OUTLINES

OF

LESSONS IN BOTANY

FOR THE USE OF TEACHERS, OR MOTHERS STUDYING WITH THEIR CHILDREN

BY

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PART II.: FLOWER AND FRUIT

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BOSTON, U.S.A.
GINN & COMPANY, PUBLISHERS
1896

Typography by J. S. Cushing & Co., Boston, U.S.A.

Presswork by Ginn & Co., Boston, U.S.A.

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I.

EARLY BULBOUS PLANTS.

WHEN we come to the study of flowers we are met at once by a serious practical difficulty, the lack of material. In New England the native spring flowers begin to appear late in April, and we wish to begin our lessons in March. If we wait until we have plenty of out-of-door flowers, there is not time enough in the remaining school year to do justice to our subject, and, moreover, the interesting specimens soon arrive so rapidly, that while we are learning the first simple principles of analysis some of the best examples of more recondite points have escaped us.

But in March the Snowdrops and Crocuses are blooming out-of-doors, and the windows of our houses are gay with Tulips, Hyacinths, and Daffodils. These flowers are simple in struc-

ture, and so large that they are very excellent for our purpose.

In my opinion it is a mistake to avoid the use of technical terms, even with young pupils, but they need not generally be memorized. A written description should be made of each flower studied, and the terms will soon become familiar by use. This is not always the case, however, for classes differ extraordinarily in their power of learning technical words, and the teacher will have to use his own judgment as to the rapidity with which new terms shall be supplied, and the amount of memorizing necessary.

It is very desirable that the pupils should learn to make careful drawings of the flowers studied, with their separate parts.

It is useful to have specimens of the first flowers examined for comparison with those studied later. For this purpose growing plants should be kept in the schoolroom and the pupils encouraged to observe their growth.[1]

[1] The bulbs of Tulips, Hyacinths, etc., should be planted in the fall in shallow pots or boxes. The soil should be rich, but

Each pupil should be provided with a mounted *lens, a sharp penknife, and some needles in wooden handles. A piece of mica to hold sections* will also be useful.

The following directions indicate the way in which a simple flower may be studied in order to learn the structure and arrangement of its organs. Each pupil should have two specimens if possible.

TULIP (*Tulipa Gesneriana*).[1]

1. Notice the flower as a whole. Describe the different sets of organs and note their arrangement.

light; if it is too heavy it may be mixed with sand. Tulips, Hyacinths, and Daffodils should be planted near the surface; Crocuses several inches deep. The pots should be covered with ashes, thoroughly watered once, and placed in a cellar where they will be safe from frost. After the shoots appear above the ground the plants should be taken into a cool room and kept well watered till they blossom. The ashes may be removed when the pots are taken from the cellar.

[1] See Appendix, p. 287.

Care should be taken to procure single flowers. These cultivated plants vary greatly, and all sorts of queer freaks occur. Monstrosities are instructive to trained botanists, but for beginners it is important to have the flower in its typical form.

2. Remove each of the outer parts with a sharp knife, noticing the order in which each part is joined to the flower-stalk. Place these in a circle or circles,[1] as it seems best to you.

3. Remove the slender stalked bodies which stand within these outer colored parts, and place them in a circle or circles,[2] within your last circle, each opposite to the part to which it stands opposite in the flower.

4. Separate the remaining organ from the flower-stalk, and place it in the centre of your last circle.

5. Look out the names of these parts in your text-book.[3] Draw one of each kind and describe them.

6. Make a cross section of the ovary. Place it in the centre of your last circle instead of the whole pistil (Fig. 1, *a*).

7. Construct a diagram of a Tulip by repre-

[1] See Concerning a Few Common Plants. By G. L. Goodale. Boston, D. C. Heath & Co., 1888, p. 43. Diagrams like that given in the plate will be found very useful.

[2] If it is difficult for the scholars to see that the stamens are not in a single circle, this point need not be noticed.

[3] Gray's First Lessons. Ivison & Co., 1889.

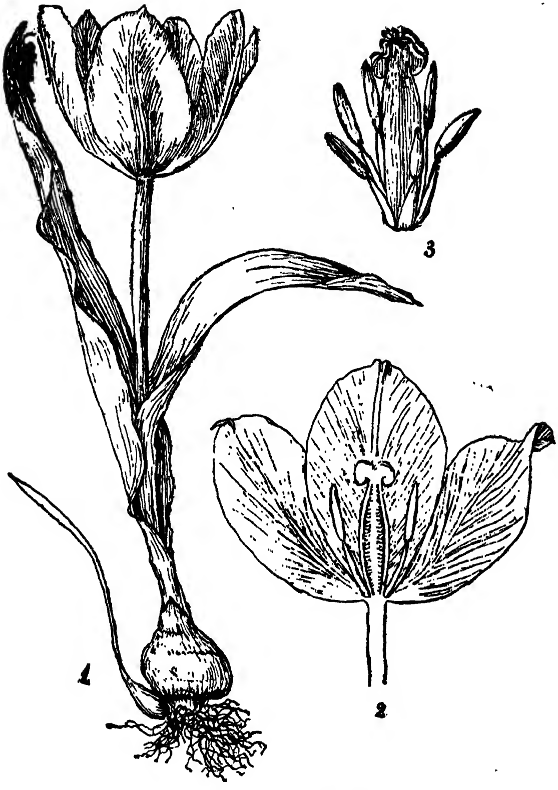

Fig. 2.—Tulip. 1. Whole plant. 2. Vertical section of flower. 3. Pistil and stamens.

senting the perianth leaves in cross section, the stamens by a cross section of the anthers, and the pistil by a cross section of the ovary (Fig. 1, *b*).

This is a ground plan of the flower. If we have plenty of material let the scholars make also a vertical section of the flower.

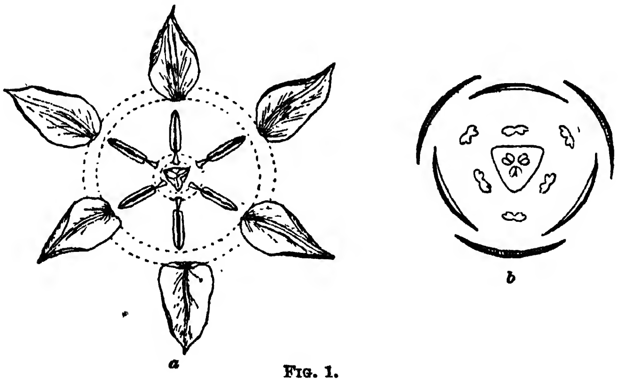

FIG. 1.

8. Take another Tulip, hold it upside down, cut it off about a quarter of an inch below the flower, and divide it in halves, beginning with the stalk. This makes a vertical section (Fig. 2, 2). Describe it, verifying the position of each organ, as you found it before. Make a diagram repre-

senting all the parts (Fig. 3). This vertical diagram will show the *adnation*, or union of the different circles with each other, which we could not show in our ground plan.[1]

If the pupils have thus described the Tulip in the class-room, they may prepare for the next recitation by rewriting their notes, using the technical terms for the parts of the flower, and adding a description of the leaves, stem, root, and manner of growth.[2]

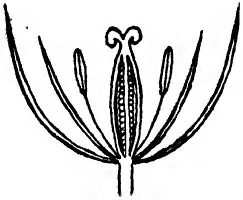

FIG. 3.—Diagram of Tulip in vertical section.

Let us see what our examination has taught us. The Tulip has six flower-leaves which make up the *perianth*. They are arranged in two alternating circles, an inner and an outer circle. This

[1] The object of a vertical diagram is simply to show the adnation of the different circles. It must be always taken in connection with the ground plan, which shows the arrangement of the parts of the flower.

[2] The leaves, stem, root, etc., have been treated in Part I, and it is taken for granted that the pupils are familiar with their forms and can describe them without difficulty. If this is not the case more time must be spent on each specimen.

was shown in the arrangement of the flower-leaves on the table and in the diagrams. It is easily seen in the bud, the three outer leaves being folded outside the three inner ones. They are all separate from each other and free from the other organs of the flower.

The outer circle of flower-leaves is named the *calyx*, and each leaf is a *sepal;* the inner circle is called the *corolla*, and each leaf is a *petal*. The sepals of the Tulip are a little larger than the petals, but they are so much alike that it is better to describe them both as perianth leaves.

The stamens at first appear to be in a single row, but it can generally be seen in a bud that the three stamens opposite the outer leaves of the perianth are outside the other three, and should be placed in a circle by themselves. We have thus two circles of colored flower-leaves, the calyx and corolla, two circles of stamens, and a pistil in the middle, which has three parts called *carpels*, united to form a three-celled ovary, crowned by the three stigmas.[1] The cells of the

[1] The number of carpels can generally be determined by the number of cells, placentæ, styles, or stigmas.

ovary alternate in position with the inner row of stamens (Fig. 1, *b*).

The whole flower is, therefore, arranged on the plan of three, each circle of three members alternating with the one before. The first descriptions of flowers will be very simple ones, consisting almost entirely of the arrangement and union of the circles and the number of members in each circle.[1] A complete description of each flower studied will be found in the Appendix.

Hyacinth (*Hyacinthus orientalis*).[2]

Let each pupil separate two flowers from the spike.

1. Holding the flower upside down, make a

[1] Dr. Goodale gives the following questions for the first flower studied: —

1. How many parts are there in each circle, and how are they arranged?

2. How are the parts of the same circle united together?

3. How are different circles united? — Concerning a Few Common Plants, p. 45.

These points are far more important in classification than the shape and color of the parts.

[2] See Appendix, p. 288.

vertical section dividing it in halves.[1] Draw it, make a diagram of it, and describe the parts and the way in which they are joined. How does this flower differ from the Tulip?

2. Make a cross section of the ovary in your second flower. Make a ground plan of the flower.[2]

It will be seen at once that the chief difference between the Hyacinth and the Tulip is that the former has a bell-shaped perianth, while the perianth of the latter is composed of six distinct leaves, and that in the Hyacinth the stamens are joined to the perianth; in the Tulip they are on the receptacle, entirely free from the perianth.

The manner of growth is as follows: The sepals and petals appear at first as separate parts, but they soon cease to grow at the tips,

[1] In beginning an analysis a vertical section of the flower should always be made. The order given for the Tulip was simply a first study of a flower.

[2] Eichler, in his Blüthendiagramme, does not indicate the union of the sepals and petals in his diagrams, but there is no reason why this should not be done by adding dotted lines joining the parts.

and are then pushed upward by an intercalary ring of tissue which develops below them. This forms the bell-shaped portion of the perianth, upon which the separate leaves and the distinct stamens have been raised. The various terms in use in our text-books, implying that the perianth leaves are united, as gamophyllous, gamosepalous, gamopetalous, etc., must not be taken in a strict sense to mean the actual cohesion of the leaves, sepals, or petals.[1]

The sepals and petals can be distinguished in the Hyacinth, for three of the lobes are outside the other three in the bud. The stamens face inwards. The number of cells in the ovary, and the arrangement of the ovules, is the same as in the Tulip. A good way for the pupils to observe the ovules, if they have not microscopes, is to slip their sections within thin plates of mica,

[1] The coherent cup-shaped or tubular portion (of the perianth), therefore, is not formed of parts originally free and subsequently united by their sides, but it grows up from the first as a whole which may be said to be intercalated at the base of the perianth leaves; the leaves which were at first free, are the marginal teeth of the common basal portion. — Outlines of Classification and Special Morphology of Plants. By Dr. K. Goebel, Oxford. At the Clarendon Press, 1887, p. 351.

which they can hold up to the light and examine with their lenses.

The pistil of the Hyacinth has another part, the *style,* which is absent in the Tulip.

The Tulip has a single solitary flower at the top of the stem; the Hyacinth has a cluster of flowers on a common stem, each borne on a little stalk of its own.

As to the vegetative characters of the two plants, they differ in that the Tulip has the stem prolonged above the ground, bearing generally two leaves, while in the Hyacinth the stem is not developed above the bulb and there are a number of leaves rising directly from the bulb. A vertical section will disclose the stem as a flat plate at the base of the bulb, with the leaves springing from it, and the flower-stalk in the centre.

Crocus vernus.[1]

If a beginner breaks off the flower of the Crocus, he will be almost sure to think that it has no ovary. We have to dig deep into the earth

[1] See Appendix, p. 289.

to find it, and sever the flower very near to the bulb. We must take the whole plant for study, making a vertical section from the very base (Fig. 4, *A*, 1). We shall find that the flower has the leaves of the perianth united like the Hyacinth, but that the shape of the flower is very different, the perianth of the Crocus having a long, slender tube. It differs from both the Tulip and the Hyacinth, in having the base of the perianth joined to the ovary, and in possessing only three stamens.

The stigmas of the Crocus are petal-like, and of a bright yellow color. Saffron is obtained from the stigmas of another species (*Crocus sativus*). The stigmas are dried and pressed into cakes. In England Saffron is the common name of the Crocus.

After the Crocus has flowered, the leaves, which have been rolled inward from both margins, expand and appear much broader than before (Fig. 4, *A*, 2). The whole leaf-surface is needed to make a new store of food for the leaves and blossoms of the following year. This store of new food is deposited in the base of the

FIG. 4.—*A.* Crocus: 1. Whole plant. 2. Leaf after flowering. 3. Stamens. 4. Vertical section of ovary. 5. Pod. (The dotted line represents the level of the ground.) *B.* Snowdrop: 1. Whole plant. 2. Section of bulb. 3. Stamens. 4. Diagram (Eichler).

stem just above the old bulb, or *corm*,[1] as it is properly called, and forms a new corm there (Fig. 4). As this corm is above the old one the plant of next year will not be so deep in the ground, and in a few years it will become necessary to take up and replant the corms, or the stock will run out.

The bracts of the Crocus ought to be noticed; three sheathe the flower itself, and three others enclose the whole growth of the season, leaves, flower, and all.

The pod of the Crocus reaches the surface of the ground when ripe, and often rises above it (Fig. 4, *A*, 5). We can see the top of the large capsule peeping above the ground. The advantage of maturing its seed underground is not exactly apparent in the Crocus. The reason has been given that coming so early in the spring the seeds are kept safe from frost. But we have other as early flowers that dispense with such protection, as the Snowdrop, for instance. There is an autumn Crocus (*C. nudiflorus*), where the seeds lie buried all winter. In the spring the

[1] See Outlines, Part I, p. 51.

stalk of the pod elongates and brings the capsule to the surface of the ground, where it arrives about the beginning of the haying season, and when the capsules discharge the seeds are scattered far and wide. Our spring Crocus, however, matures its seeds at once.

SNOWDROP (*Galanthus nivalis*).[1]

In this flower the two circles of the perianth, calyx and corolla, differ in shape and coloring. The outer flower-leaves are larger, and are pure white, the inner are notched and spotted with green. This is the reverse of the usual coloring, as in most flowers the calyx is green.

The base of the perianth is joined to the ovary, but it differs from the Crocus in having the stamens inserted on a disk on top of the ovary, instead of on the perianth. Many botanists regard such ovaries as enclosed in a hollow receptacle, and this seems to be the best explanation in the case of the Snowdrop. Others regard the calyx tissue as consolidated with the ovary into a single green body. We cannot

[1] Appendix, p. 290.

judge of the merits of the case, and will simply describe the petals and stamens as "inserted on a disk on top of the ovary" (*epigynous*).

Notice the nodding position of the flower and the cleft bract from which it nods (Fig. 4, *B*, 1). A diagram, both in vertical and cross sections, should be made of every flower studied (Fig. 4, *B*, 4).

The flowers of Trillium are excellent to compare with the Tulip and Snowdrop. They can be forced in a greenhouse by bringing in the plants in the fall. *Trillium grandiflorum* is a striking example of a perianth where the outer circle resembles the inner in shape and veining, but differs in the texture and color. If no fresh flowers can be obtained, pressed specimens will answer very well. The Trillium is similar to the Tulip, being arranged in circles of three members each, but it differs in having the outer leaves of the perianth green.

Other flowers that may be compared with those we have studied, or may replace them, are Lilies, Scilla, Amaryllis, Narcissus (*N. poeticus*), Jonquil (*N. Jonquilla*), Daffodil (*N. Pseudo-Narcissus*), and Freesia.

The various species of Narcissus will puzzle the pupils by the crown (*corona*), which they will certainly describe as a corolla. This crown is an outgrowth from the perianth. In some flowers, as *Narcissus poeticus*, it is an insignificant little cup. In the Jonquil it is longer than the perianth.

Let us put very brief descriptions of the flowers we have studied side by side.

TULIP.

PERIANTH.	STAMENS.	PISTIL.
6 leaves, distinct, free from ovary.	6, distinct, free.	3 carpels, united, ovary superior.

HYACINTH.

PERIANTH.	STAMENS.	PISTIL.
Bell-shaped, 6-lobed, free from ovary.	6, distinct, joined to perianth.	3 carpels, united, ovary superior.

CROCUS.

PERIANTH.	STAMENS.	PISTIL.
Funnel-shaped, 6-lobed, joined to ovary.	3, distinct, joined to perianth.	3 carpels, united, ovary inferior.

SNOWDROP.

PERIANTH.	STAMENS.	PISTIL.
6 leaves, distinct, joined to ovary.	6, distinct, on an epigynous disk.	3 carpels, united, ovary inferior.

When the ovary is free it is called *superior*, when it is joined to the calyx it is *inferior*.

We wish to show the place that these flowers hold in our scheme of classification. In the Appendix will be found a schedule showing the general arrangement of flowering plants as classified in our Manual. The pupils are already familiar with the secondary characters by which they can place the plants among the monocotyledons, the parallel veining of the leaves, and the monocotyledonous type of the structure of the stem.[1] Our flowers evidently belong to the first of the three divisions of the monocotyledons (*petaloideous*) for they have colored petals.

The Tulip and Hyacinth are put at once into the Lily family (*Liliaceæ*), because the ovary is superior, the stamens six in number, and the perianth leaves colored alike.[2] The Crocus belongs to one of the families with inferior ovary. As it has three stamens we put it into the Iris family (*Iridaceæ*), and the Snowdrop, with infe-

[1] Outlines, Part I, pp. 34, 119.

[2] The Trillium is an exception, having green sepals.

rior ovary and six stamens, we place in the Amaryllis family (*Amaryllidaceæ*).

It must be understood, however, that only the best known and most important of our native families are placed in this schedule.

Parts of the Flower.

All these flowers have *calyx*, *corolla*, *stamens*, and *pistil*. They are therefore called *complete*. They are also *regular*, the members of the same circle being alike in shape and size, and *symmetrical*, having the same numbers of members in each circle.[1]

The calyx and corolla taken together are called the *floral envelopes*, or the *perianth*. The calyx is the outer circle, the corolla the inner circle of the perianth. The parts of the calyx are called *sepals*; the parts of the corolla are *petals*.

A *stamen* consists of a *filament*, or stalk, and

[1] The term *symmetrical* is used without taking the pistil into account. This term is employed by German authors in a different sense. It is applied to a flower which can be divided into similar halves.

an *anther*, which holds a substance called *pollen.* The anther is the only essential part of a stamen. When the filament is absent, the anther is sessile. Anthers are generally two-celled. In all the flowers we have examined they are two-celled and split throughout their whole length to discharge their pollen (*longitudinal dehiscence*), except in the Snowdrop, in which the anther splits only a little way and discharges through a small slit near the top.

Anthers may be fixed by the back (*dorsifixed*), like the Crocus, or by the base (*basifixed*), like the Tulip. When they are fixed by the back they may face inward (*introrse*), like the Hyacinth, or outward (*extrorse*), like the Crocus, or they may be fastened in the middle and tilt back and forth, like the Lily, in which case they are *versatile.*

The *pistil* occupies the centre of the flower. It is made up of parts, called *carpels*, just as the calyx is made up of sepals and the corolla of petals. In all the flowers we have thus far studied there are three carpels, and the carpels are united.

When such a pistil is complete it consists of an *ovary*, a *style*, and a *stigma*.

The *ovary* holds the *ovules*, which are to become seeds. In the flowers we have studied the ovules are all joined to the centre of the ovary (*central placenta*), in two rows in each cell.

The *style* is not an essential part of the pistil. It is absent in the Tulip, and the stigmas are *sessile*.

The *stigma* is the part of the pistil which receives the pollen, as will be explained in the following chapter.

The *receptacle* is the top of the stem to which all the parts of the flower are joined.

Gray's Lessons, 228–238.

II.

COMMON HOUSE-PLANTS.

If we have begun our flower-lessons in March, it is still too soon in New England to find out-of-door material for study, and we will treat of some house-plants before passing to the early spring flowers.

One of our most constant companions is the House-Geranium. It requires very little care, is not attacked by insects, and rewards us for a slight trouble by an abundance of blossoms.

House-Geranium (*Pelargonium zonale*).[1]

The pupils should make a brief description of the flower, noticing in particular the number of parts in each circle, and the union of parts of the same circle and of different circles. A ver-

[1] See Appendix, p. 293. The species of Pelargonium have been so much mixed in cultivation, that it is difficult to find one of the original type, and all sorts of variations must be expected.

tical section is always necessary. A bud, or just opening flower, is always best for the examination of the anthers. The stamens may give some trouble, as some of them are without anthers and sometimes all are sterile.

Besides this description of the flower, the pupils should write out all that they can observe about the plant, its manner of growth, its root, when this is possible, its stem, and foliage. As new plants are studied, the descriptions should be enlarged from lesson to lesson, until they finally become, after many lessons, as full as those given in the Appendix. This will supply quite enough work to be done out of school, as soon as plenty of specimens can be obtained. All this work should be kept carefully in note-books with the opposite page left blank for corrections, and as much drawing as possible should be done.

Here is a very simple description of the House-Geranium.

CALYX.	COROLLA.	STAMENS.	PISTIL.
5 sepals, distinct (*polysepalous*), free.	5 petals, distinct (*polypetalous*), free.	10, 7 with anthers, filaments united (*monadelphous*), free.	5 carpels, united (*syncarpous*), free.

How does this flower differ from the Tulip?

The most obvious difference is that the parts are in fives instead of threes. Monocotyledons never have their flowers arranged on the plan of five. Another noticeable distinction is that the calyx is green, while the inner circle, the corolla, is colored. In the Tulip both are colored.[1]

Therefore, in describing the Geranium we use the words calyx and corolla instead of perianth. The latter word is only used when there is no obvious distinction between the circles, as in the Tulip, or when a flower has its nearest connections among those where no distinction exists, as in the Snowdrop and Trillium.

Let us now examine some points in the growth of the House-Geranium.

Under favorable circumstances it is a shrub. The small plants in our houses are not woody, but if we see a plant that is several years old we shall see that it is woody.

The leaves are sometimes opposite, sometimes alternate, but usually alternate. They have

[1] The word *colored* is used to denote any color except green.

stipules, joined to the stem, which soon drop off or become dry and scaly.

The inflorescence is peculiar. The flower-stalk grows apparently on the side of the stem opposite a leaf. We learned in a former section (Part I, p. 57) that buds were either terminal or axillary, and flower-buds are no exception to this rule. How, then, are we to account for the position of the flower-cluster here? If it is possible to examine a very young bud, we shall find that it really terminates the stem, but by the more vigorous growth of the branch in the axil of the neighboring leaf it is thrust aside. It is an analogous case to the flower-scar of Horse-chestnut, which we studied among the buds.[1]

The flower-cluster is surrounded by a circle of bracts, which envelop the whole cluster when young, and answer to the scales of a leaf-bud. The number of flowers in the cluster varies.

The seeds of House-Geranium are very interesting. They do not often develop in the house. The five carpels composing the pistil separate, when ripe, from a central column, which is a

[1] Outlines, I, p. 61.

prolongation of the receptacle. The carpels split apart from below upward, and remain hanging by their styles, till a puff of wind or some disturbance detaches them and they are carried away, often quite a distance from the plant.

Before leaving the parent, the long style of the carpel has become twisted into a spiral, by the contraction in drying of the outer fibres. The upper end of the style remains straight, forming a long awn. The middle of the style is lined with a thick brush of soft, white hairs, which form a sort of parachute when the twisting takes place, and add greatly to the power of the fruit to fly to a distance from the parent plant.

When the dry fruit is placed on a damp surface the contracted fibres absorb water and begin at once to elongate, causing the spiral to uncoil. If the fruit has fallen in a favorable position, the awn soon becomes pressed against the earth and the carpel rises in the form of an arch. The end containing the seed becomes pointed downward, and the further uncoiling acts like a corkscrew and pushes the seed into the ground. The thick end of the fruit holding

the seed is covered with fine, upward-pointing bristles, so that it is easy for the seed to enter the ground, but impossible for it to be withdrawn. As soon as the ground dries the carpel begins to coil up, and with successive changes of moisture the process is repeated again and again.

The Erodium, a near relative of the Pelargonium, has fruits in which this arrangement is much more perfect, as it has more turns in its spiral, and is thus forced downwards with more force. I have seen a fruit of Erodium bury itself in three minutes. If the fruit of Pelargonium be left for a day in loose, damp soil, however, it will often succeed in wriggling itself partially underground.

GARDEN NASTURTIUM (*Tropæolum majus*).[1]

In the introduction to the first part of this book it was recommended that Tropæolum seeds should be planted in pots and allowed to grow over a sunny window in the schoolroom. If this has been done, the teacher will now have blos-

[1] Appendix, p. 291.

soms. These flowers can often be obtained in greenhouses, but they are easily grown in the house, and one has only to plant the seeds early in the winter, and to keep the plants well watered in a moderately cool room, in order to have sufficient material for a large class. The young seedlings should always be transplanted from the pot in which they have germinated.

Let the pupils begin the study of the flower as usual by making a vertical section. Compare the flower with that of the House-Geranium.

The parts are also in fives, at least as to the floral envelopes, but the calyx has five lobes (*gamosepalous*) instead of five separate sepals.[1]

[1] "The proper term for a corolla or a calyx, the leaves of which are more or less coalescent into a tube or cup, is *gamopetalous* for such a corolla, *gamosepalous* for the calyx; these terms meaning united petals or sepals. The older and misleading names *monopetalous* or *monosepalous*, although current up to a recent day, should be discontinued." Gray's Structural Botany, p. 244.

The same objection applies to the use of the term *polypetalous* for which the term *choripetalous* is sometimes substituted.

But these terms are misleading also, as the sepals and petals are not united, but only raised on a subsequent ring of tissue. Masters, in Botany for Beginners, London, 1889, tries to get

This follows from a method of growth, like that of the corolla of the Hyacinth (p. 9). The stamens are eight in number. The pistil has three carpels. These are joined together, but when the pistil is ripe they split apart into three closed *nutlets*, which are generally called seeds (Fig. 5, 6). The real seeds are inside, one in each cell.[1]

Let us put brief descriptions of the Pelargonium and Tropæolum side by side.

PELARGONIUM ZONALE.

CALYX.	COROLLA.	STAMENS.	PISTIL.
5 sepals, polysepalous, free.	5 petals, polypetalous, free.	10, 7 perfect, monadelphous, free.	5 carpels, syncarpous, free.

TROPÆOLUM MAJUS.

CALYX.	COROLLA.	STAMENS.	PISTIL.
5 sepals, gamosepalous, free.	5 petals, polypetalous, joined to calyx.	8 stamens, distinct, joined to base of calyx.	3 carpels, syncarpous, free.

over the difficulty by coining a new term, *inseparate*, to describe the sepals and petals of a gamopetalous calyx, but as the dictionary defines inseparate as "united," it is hard to see what is gained thereby. It seems to me quite impossible to make our descriptive terms thoroughly scientific.

[1] Other interesting points about the Tropæolum will be found treated in Part I, pp. 108, 109, and 130.

FIG. 5. — Garden-Nasturtium. 1. Front view of flower. 2. Side view of flower. 3. Vertical section. 4. Flower-bud. 5. Leaf. 6. Fruit. 7, 8, 9. Stamens and style in successive stages. 10. Diagram (Eichler).

If we wish to place these flowers on our schedule we shall find that they belong in the first division, since they are dicotyledons and polypetalous.

The stamens and petals of the Pelargonium are inserted under the ovary, while those of the Tropæolum are united with the very base of the calyx, except two petals, which are inserted higher up. We should, therefore, place the first flower in the first group on the schedule, while we should naturally expect to find the other in the perigynous group. But the Tropæolum is an exception to most of its relations in this respect, and belongs to the Geranium family, which is classed as hypogynous.

There are no easy constant characters to distinguish *Geraniaceæ.* It is composed of several strongly marked tribes, which are described by German authors as separate families. It is a difficult matter to decide on the limits of species, genera, and families, and the doctors themselves disagree.

It used to be thought that species did not vary. We may still read in Wood's Botany: "When

He called plants into existence in their specific forms, He endowed each with the power of perpetuating its own kind and no other, so that they have descended to us endowed with the same character and properties as at the beginning. When, therefore, the student has formed acquaintance with any individual plant, he is also acquainted with all other individuals belonging to the same species." [1]

Against this we may quote Dr. Gray: "He (the naturalist) can only ejaculate the wish that this ideal vegetable kingdom was the one he had to deal with." [2]

No two individuals are exactly alike. Sometimes the descendants of a single plant will differ so much that they would be thought distinct species if we did not know they had a common origin. Such forms, when they become fixed, are called varieties. It is by choosing out and cultivating varieties that we have obtained so many different colors of Roses and Chrysan-

[1] Class-Book of Botany. Alphonso Wood. A. S. Barnes, New York, p. 165.

[2] Natural Science and Religion. By Asa Gray. Charles Scribner's Sons, New York, 1880, p. 41.

themums, for instance. The word *chrysanthemum* means golden flower, but now we have red and white ones also. Our modern view supposes that species have been developed in a similar way from a common ancestor and that "Classification, so far as it is natural, expresses real relationship. Classes, orders, tribes, etc., are the earliest or main and successful branches of the genealogical tree; genera are later branches; species the latest definitely developed ramifications; varieties the developing buds."[1]

To classify these groups wide knowledge is necessary and even trained judgments differ.

For a beginner to place the Pelargonium and Tropæolum in the right family it would be necessary to use an artificial key, such as the one with which Gray's Manual is provided. But it is a mistake to take the key into use until the pupil has learned to use his eyes intelligently and is familiar with the ordinary terms, and even then he should never attempt to look out

[1] Gray's Structural Botany, p. 329. Read the whole chapter on the "Principles of Classification." The teacher is recommended to read also Darwin's Origin of Species.

a flower until he has first made a description of it. Therefore, he will have to be told the place of these flowers on our schedule. Most families, however, are distinguished by more obvious characters than the Geranium family, and these ought to be learned with every flower studied, even after the key has been taken into use. We may go on using the key for a year, and after that time have no more idea where to place a new flower than at first. On the other hand, if we learn the distinguishing characters of each order that we study, and the place that it holds in a Natural System, we learn something of the real affinities of the flower.

The Tropæolum is very good for the study of cross-fertilization, and it will add much interest to the study of flowers if we begin early to notice their various contrivances for that end.

Cross-Fertilization.

Why is it that we must keep our Sweet Peas or Nasturtiums cut if we wish the plants to continue to flower?

This question is one that will set the pupils

thinking, and they will probably perceive, after a little thought, that if the plant is allowed to go to seed it will the sooner stop flowering. This indicates that the purpose of the flower is to produce seed, which is to perpetuate the plant in its offspring. In fact, every part of the flower is adapted for this end. This is the key to unlock the mysteries of their varied forms.

Ask the pupils what organs are necessary to this object. They will think at once of the pistil, which can readily be seen to develop into the fruit, but it is probable that the teacher will here be obliged to explain the action of the pollen on the ovule, in order to show the necessity of the stamens.

A grain of pollen falling upon a mature stigma sends out a slender tube, which grows down through the style until it reaches the ovary and enters an ovule there. By the mixture of the protoplasm in the pollen grain with that of the ovule, fertilization is effected and the embryo begins to form.[1]

[1] Gray's Botanical Text-Book, Vol. II. Physiological Botany. George L. Goodale, p. 426.

Organs, as the scholars have already learned, are the parts of a living being that do definite kinds of work.[1] Since the parts of a flower necessary to the production of seed are the stamens and pistil, these are the *essential organs*. They are essential to the purpose of the flower; in fact, they may really form the flower itself. Our word *perianth*, which means "around the flower," indicates that the floral envelopes are as truly accessory parts as the bracts. Does a flower produce seed if it has only one of these essential organs? If the pupils think not, how can they account for the acorns of the Oak, which develop from a flower possessing no stamens? The study of the "pussies" of Willow, which blossom in early spring, will be very useful in this connection, although for purposes of convenience they are placed in a later chapter. Indeed, the Willow is a very excellent flower to begin our lessons upon, for the reason that it shows a flower reduced to its simplest terms, and will not impress the pupils with the erroneous idea that showy floral envelopes constitute a flower.

[1] Outlines, Part I, p. 2.

The question now naturally arises why a flower should have any other parts than its essential organs, and this can be partially answered by an examination of our flower.

Examine specimens of Tropæolum in all stages, from the bud up to the withered flower, in order to answer the following questions: —

1. What is the position of the stamens before discharging? While discharging? Do they all discharge at once? While discharging, what is their position with reference to the spur?

2. What is the condition of the style while the stamens are discharging and after they have discharged?

3. What is the use of the spur?

4. To what point do the dark lines on the calyx and corolla converge?

5. Does the flower stand erect? Is there any reason why it would be injurious to do so? On which petals is the fringe?

A bud, just opening, will show the stamens all bent downward (*declined*), in the position represented in Fig. 5, 7. In a little older flower our stamen has risen (Fig. 5, 8), and stands

directly in the path to the spur. As the flower grows older, the stamens rise one by one until all have discharged. In those that I have observed, the time for all to discharge occupies about three days.[1]

While the stamens are discharging their pollen, the style is short and the three branches are not expanded (Fig. 5, 7, 8), but after the stamens are withered, the style elongates until it stands exactly where each stamen in turn stood, and the three branches, each bearing its stigma, spread widely open (Fig. 5, 9).

If the end of the spur be cut off, nectar will be found there. The pupils know that bees make honey from flowers, and can be led to think what use this may be to the flower. As the stamens and style are not mature at the same time, the flower is not adapted for self-fertilization, and must be fertilized in some way with pollen from another flower. Since the stamens while discharging stand directly in the path to

[1] This regular order of dehiscence is often spoiled by insects eating the pollen and preventing the stamens from following their normal course, so that it may be necessary to pick all the flowers in bud, and let them develop in the house.

the nectar contained in the spur, pollen will be rubbed off on the body of an insect in search of the nectar, and this pollen will be left in an older flower on an expanded style standing directly in the path to the spur.

The dark lines on the calyx and corolla converge towards the tip of the spur where the nectar is contained. The name *nectar-guides* has been given to such markings. It has been found that they always point to the part of the flower where the nectar is obtainable, and they are thought to guide the insects. The corolla generally fades as soon as fertilization is accomplished. One use that it serves is to attract insects by its color to the feast spread for them.

The position of the flower makes a convenient landing-place for insects, and it also shelters the nectar from injury by the rain. Sprengel suggests that the use of the fringe is to prevent the rain running down the claws into the spur. This seems to me fanciful, as I cannot see from my experiments that it would do so in any case. It would be well to have the pupils subject the flowers to an artificial rain from a brush. They

can try the experiment of removing the fringe and see if the rain gets in. If the flower is held up the water runs directly into the spur, showing that its nodding position is a protection. Moreover, the force of the rain itself bends the flower downwards, so that all the water is received on the outer part.

This transfer of pollen from one flower to another is known as *cross-fertilization*.[1] The term is applied by Darwin to crossing with a distinct plant. The subject is one of the most interesting to students in the whole range of Botany. The fact that it is brought about by such varied contrivances and in plants belonging to families so widely separated, would lead us to conclude that it must be of great use to the offspring. Darwin has proved in a number of cases that a plant will not set seed when fertilized exclusively with its own pollen, and in others that the offspring of self-fertilized plants were not so strong as those of the same species of plant when cross-fertilized.[2]

[1] A Reader in Botany. Part II. Flower and Fruit. Boston, Ginn & Co., 1892. I.

[2] The Effects of Cross and Self-Fertilization in the Vegetable Kingdom. Charles Darwin.

The subject was first treated by C. C. Sprengel,[1] who in 1793 published a treatise on flowers requiring insect aid for their fertilization. This book attracted little notice from scientific men. In 1862 Charles Darwin published his treatise on the "Fertilization of Orchids,"[2] which has been followed by a large number of books and papers on the subject.[3]

An account of the fertilization of Tropæolum by Sprengel will be found in the Reader,[4] and the pupils, *after having completed their own observations*, will be pleased to read what was observed nearly one hundred years ago.

Let us now examine the House-Geranium.

1. Can you see any markings in this flower which would indicate the path to the nectar? Does the arrangement of the stamens give you any idea where to look for it?

[1] C. C. Sprengel. Das Entdeckte Geheimniss der Natur. Berlin, 1793.

[2] On the Various Contrivances by which British and Foreign Orchids are Fertilized, etc. Charles Darwin.

[3] A Bibliography of the subject, up to 1883, will be found in The Fertilization of Flowers; a Translation, by D'Arcy W. Thompson, from the German of H. Müller.

[4] Reader in Botany. II.

2. Where is the nectar contained in this flower? It belongs to the same family as the Tropæolum. Can you see any resemblance between these flowers in their manner of holding the nectar?

The markings in this flower are often very slight. There is generally, however, a difference of color in the two upper petals, and these are veined with darker lines than the lower ones. In some species of Pelargonium the two upper petals are conspicuously streaked and spotted. These two upper petals in our specimen are also narrower than the lower and stand more erect, making the flower somewhat irregular. The stamens are shorter towards the upper petals, so that an insect creeping into the flower on its upper side would be dusted with pollen from all the stamens. These facts should lead the pupil to examine the bases of the two upper petals carefully.

There he will discover a small hole from which a narrow tube extends downward nearly to the base of the pedicel. This tube is really formed by the upper sepal being adnate to the pedicel,

and is called a *concealed spur*. Imagine the spur of the Tropæolum adnate to its flower-stalk, and you have the arrangement of the Pelargonium.

Sometimes in our gardens we find flowers without any nectar-guides, and Darwin has pointed out that this is correlated with the abortion of the spur.[1] This is a proof that the color is connected with cross-fertilization.

The style, as in Tropæolum, is not lengthened or expanded until the stamens have ceased discharging. This is called *dichogamy*. Both the Tropæolum and the Pelargonium are dichogamous. This secures cross-fertilization, and the flowers, therefore, seldom set seed in the house, where insects are absent, except an occasional fly. It would be interesting to try some experiments of artificial fertilization on the schoolroom plants.

One teacher has told me that her method of starting the subject of cross-fertilization was to go out in the garden with her pupils, and set

[1] The Variation of Animals and Plants under Domestication. By Charles Darwin. Orange Judd & Co., New York. Vol. II, p. 414.

them to watching the bees and other insects at the flowers. She showed them the pollen on the bodies of the bees, and told them to observe what part of the flower it touched. I cannot imagine a better way of awakening a quick interest in the living study, but it is seldom, perhaps, that a teacher is able to carry out such a plan, and the present volume supposes the lessons to be given in the very early spring. I may say, once for all, that the more one is able to put aside the ordinary schoolroom methods, and learn directly from Nature herself, the more likely is the study to prove of abiding interest and value.

We are now in a position to understand better the uses of the parts of the flower.

The calyx and corolla are protective and attractive organs. If we examine the bud in a young state we shall see that the floral envelopes protect the essential organs while they are in a young state.

The corolla offers attractions to insects in its color. Occasionally the calyx also is useful in this way, as in Tropæolum. Both of these

organs are often modified to secrete and to hold nectar, and to act as platforms upon which the insect may alight.[1]

The stamens contain the fertilizing substance, (*pollen*), which is essential to the production of seed. The anther is the portion of the stamen which holds the pollen, and is the only essential part.

The pistil contains the ovules, which are to develop into seeds when they have been fertilized.

The ovary is the portion of the pistil which holds the ovules, and the stigma is a portion of the pistil through which the pollen tubes enter to fertilize the ovules. The style is not essential.

[1] The general form of the perianth, especially when it is distinctly petaloid in character and of some size, always stands in a definite relation to pollination by means of insects, and large, gaily-colored, delicate, strongly scented flowers only occur where fertilization is effected by them; these characters are intended to induce insects to visit the flowers; the infinite variety and often strangeness of form in the perianth are specially calculated to compel insects of a definite size and species to adopt definite positions of their bodies in their search for the nectar, and thus the pollen is conveyed, without intention on their part, from flower to flower. — Goebel's Outlines, p. 352.

Any of these parts may act as attractive organs to insects by secreting nectar. In the Violet the nectar is secreted by the stamens, and in the Marsh-Marigold (*Caltha*) by the carpels.

III.

HOUSE-PLANTS. — *continued.*

Each new description should notice more points about the flower than the preceding one. But it is impossible, as has already been said, to give any rule for the rate of progress, which must depend upon the capacity of the class. The teacher alone can judge how fast new ideas can be suggested, and with the new ideas the new terms with which to express them. It is well to make the pupils feel the need of technical terms, to allow them to describe the things they see in their own language, and discover how much trouble is saved by a single expressive word, before supplying them with the necessary terms.

Only a few points about each flower will be mentioned in this chapter, but a full account of each plant will be found in the Appendix.

Fuchsia coccinea.[1]

This flower will probably prove easy to describe. It is large and perfectly regular, complete, and symmetrical. The parts are in fours. The corolla and stamens are joined to the calyx above the ovary. The same difficulty arises here that we noticed in the Snowdrop. Shall we regard the calyx as beginning at the base of the flower or on top of the ovary? There is a difference in opinion among botanists on this point. It is probable that in certain flowers the outer covering of the ovary is formed from the calyx tissue, in others from the receptacle growing up around the ovary, and in others from a combination of both calyx and receptacle. We, however, are assuredly not able to decide where the doctors disagree, and we will simply describe the corolla and stamens as inserted on the throat of the calyx.

The Fuchsia is a good flower with which to begin the study of *æstivation;* that is, the dis-

[1] Appendix, p. 294. The species are much mixed in cultivation.

position of the parts of the flower in the bud. A bud is generally necessary to determine the æstivation. In this flower, the margins of the calyx lobes meet without overlapping, and are called *valvate*. Each petal has one edge over and one edge under its neighbors, and this is *convolute* æstivation. This arrangement of the parts of each circle in the bud must be shown in our diagrams (Fig. 5, 10).

When we wish to put the Fuchsia into the right place on our schedule, we find that it belongs near the end of the polypetalous division of the dicotyledons, because the corolla and stamens are inserted above the inferior ovary, and as the Evening-Primrose family (*Onagraceæ*) is described as having the parts usually in fours, the calyx valvate, and the corolla convolute, we place our flower under that head.

Abutilon striatum.[1]

A very good observer declared to me from memory that this flower was gamopetalous. If we look at the flower we shall see how she came

[1] Appendix, p. 295.

to make the mistake, for the petals do not spread open, but remain tightly clasping each other, so that we can see the æstivation in a full-blown flower. The corolla is convolute, like that of a Fuchsia, and if we get a tiny bud, still covered by the calyx, we shall see that this is valvate, also like the Fuchsia.

The most characteristic thing that we next notice is the long tube of stamens, enclosing the style, separated at the top into a thick cluster of anther-bearing filaments. This reminds us of the House-Geranium, where the filaments were also united, but in the Abutilon the stamens are very numerous.

The anthers are different from any we have seen. They are one-celled, and open all around the margin.[1]

It may be difficult for beginners to determine the structure of the ovary. If a thin section be slipped within a plate of mica, held up to the light, and examined with a glass, the cells can be plainly seen surrounding the central column of the style, which ends in branches. The num-

[1] Gray's Lessons, p. 102, Fig. 298.

ber of cells and style-branches corresponds and varies in different flowers. The more usual number is ten.

The nectar is lodged in five small depressions in the base of the corolla, and overflows into the bottom of the baggy calyx. A bee, flying into the flower, strikes the stigmas, which are longer than the stamens, and then the anthers. In crawling out he strikes the under part of the recurved divisions of the style and turns them backwards so that he does not touch the stigmas, but rubs off his pollen on the next flower which he enters.

The Abutilons are frequently fertilized by humming-birds. Müller found, in a series of experiments, that all which he examined were sterile with their own pollen.[1]

The Mallow Family (*Malvaceæ*) to which the Abutilon belongs, is easily recognized among the group of polypetalous flowers with the corolla under the ovary (*hypogynous*), by its staminal column with the thick cluster of anther-bearing filaments at the top, its one-celled anthers, and

[1] The Fertilization of Flowers, p. 145.

its carpels, either separate, or united around a central style. The Hibiscus, Althea, and Mallow are other members of this family.

AZALEA (*Rhododendron Indicum*).[1]

The flowers are from terminal mixed buds, which are covered with scales answering to the scales of a leaf-bud. The study of a bud while the leaves and flowers are still tightly covered with the scales is instructive. The parts are folded away in miniature. The anthers are far more developed than the rest of the flower-organs. A little older bud, where the flowers are separated, will show the æstivation, which is imbricated, and with the petals strongly ribbed.

This is our first example of a gamopetalous corolla. It is trumpet-shaped. The corolla is slightly *irregular;* that is, the petals are not all alike, and the flower is tipped sideways on the stem, as is the rule with irregular flowers. This is probably connected with the visits of insects and offers a convenient landing-place for them.

Ask the scholar where he would expect to

[1] Appendix, p. 296.

find the nectar from the position of the stamens and the coloring of the flower. The upper petals have nectar-guides formed by a darker shade of coloring toward the base. The stamens all turn toward these upper petals, and discharge in such a way that the pollen from the pores at the apex would dust an insect creeping into the upper part of the flower. While the stamens are discharging, the style is bent downwards and to one side, but when they have discharged, the style rises and the stigma occupies the same position as these stamens, directly in the path to the base of the upper petals. This can be seen by examining flowers in different stages. We should, therefore, expect to find the nectar at the base of the two upper petals, and here we shall find it. A vertical section of a flower in full bloom will disclose it, while there is none to be found at the base of the lower petals. This maturing of the style and stamens at different times is an adaptation for cross-fertilization, already noticed in connection with the Tropæolum and Pelargonium.

The anthers of the Azalea are of a new type.

They discharge their pollen from a little chink in the apex of each cell, a characteristic mode of dehiscence in the Heath family, to which the plant belongs.

The ovary is superior and five-celled, and the style is single.

Where shall we place our plant on the schedule? We see at once that it is a dicotyledon and gamopetalous. It has also a superior ovary, which brings it under our second head in the gamopetalous division. Here we should be inclined to place it among the irregular flowers at the end, but we find it might also be classified under the Heath family (*Ericaceæ*), which has both regular and irregular flowers. The fact of its having anthers opening by terminal pores would lead us to place it in the Heath family, though there are some members of this family, as our Trailing Arbutus, that have anthers dehiscing longitudinally. There are other characters which would tell a person used to observing plants where this one belonged. The leaves, so thick, hairy, and leathery, remind us of the Checkerberry, the Partridge-Vine, and

Blueberry, and the tough stems, clothed with rusty bristles, resemble many other members of the family.

Begonia semperflorens.[1]

This is an interesting example of a plant with flowers in which the essential organs are separated.

Both the staminate and pistillate flowers are on the same plant (*monœcious*).

The pupils should describe the plant and make description and diagrams of both kinds of flowers.

The leaves of Begonia have a habit of budding, and cuttings can be taken from them. A leaf pinned to the ground will throw out buds and produce new plants. If it is practicable to try experiments of this kind in the schoolroom, they will add to the interest of the lessons.

The inflorescence of Begonia is *determinate.* The main axis of the flower-stalk is terminated by a flower, which is the oldest flower on the

[1] Appendix, p. 297. The structure of all Begonias is essentially the same. Sometimes the pistillate flowers have more perianth leaves.

cluster. Below are younger axillary branches which are also terminated by flowers (Fig. 6). They spring from the axils of scaly bracts, which fall off before the flower opens (*deciduous*). All these first flowers are staminate. Later, the pistillate flowers arise from the sides of the secondary branches.

The staminate flowers have a perianth of four leaves (Fig. 6, 2, 3, 8) in two circles, the inner circle alternating with the outer, and a cluster of stamens in the centre. There is no trace of a pistil. The inner perianth leaves are narrower than the outer. The anthers are innate, the cells are small, and the continuation of the filament between the cells (*connective*) is very large (Fig. 6, 4).

The pistillate flowers (Fig. 6, 5, 6, 9) have usually a five-leaved perianth, imbricated like the corolla of Tropæolum (Fig. 6, 9), and a pistil of three carpels. The ovary is three-celled, and inferior, with a wing projecting from the back of each cell. There are three styles, and the stigmas are horseshoe shaped. The ends of the stigmas are spirally twisted in a very peculiar manner (Fig. 6, 7).

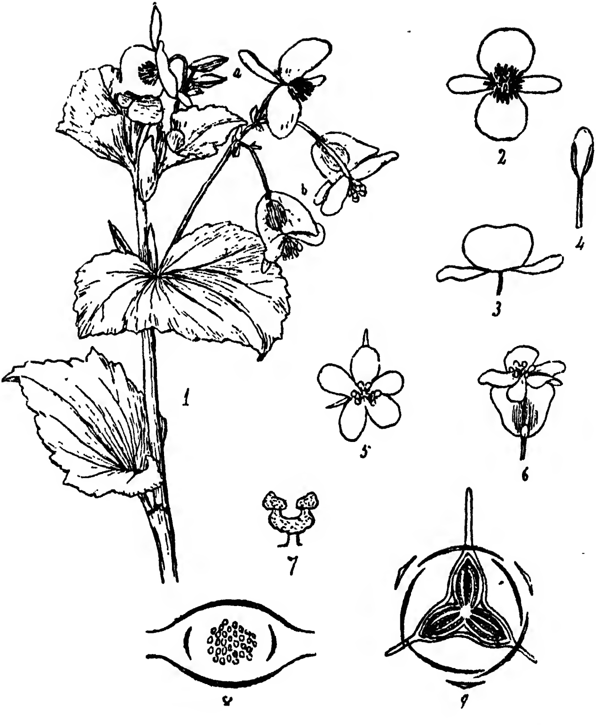

Fig. 6. — Begonia semperflorens. 1. Flowering branch. 2. Staminate flower, from above. 3. Side view of same. 4. Stamen. 5. Pistillate flower, from above. 6. Side view of same. 7. Branch of style with stigma. 8. Diagram of staminate flower. 9. Diagram of pistillate flower.

It is plain that fertilization is impossible here without some external agency. The pollen must be carried to the stigma by insects. I know nothing of the manner in which this is accomplished. My plants have set no fruit in house or garden, nor do I find anything relating to the subject in books. Müller has no remarks on this family.

The placentæ are very large, extending back into the cells (Fig. 6, 9), and the ovules are extremely minute.

The place which the Begonia F. holds in the Flora may puzzle the pupil. The staminate flowers may be regarded as having a calyx of two sepals and a corolla of two petals, but the pistillate flowers cannot be divided into two circles, as the leaves are imbricated, exactly as in an ordinary calyx (Fig. 6, 9). We must therefore use the word *perianth* in describing them, since we are ignorant of their morphology. The flower, if it had an outer and an inner circle of perianth leaves, would be placed among the polypetalous families, and as the perianth and stamens are on top of the ovary, it would come

near the end of this group. We shall find it here in the Garden Botany. Many truly apetalous flowers, as the Anemòne, for instance, are placed among the polypetalous families, because they are evidently reduced and degraded members of these families, so that there is no objection to placing the Begonia here, even if the perianth really consists of a single circle. Indeed, modern German authors intercalate the whole of the apetalous division among the polypetalous families.[1] It must not be supposed that facts of this kind are to be forced upon the pupil, but it may easily happen that a real difficulty may arise in the student saying with perfect reason, "I do not see why the flower is not apetalous." The morphology of the perianth is doubtful.

[1] The arrangement of dicotyledons by De Candolle and Endlicher into three divisions, Apetalæ, Gamopetalæ, and Choripetalæ, is now pretty well given up in theory, though still often used in practice. A. Braun has placed the greater part of the Apetalæ with the Choripetalæ, and J. Hanstein has found room there for the remainder, so that the class has now only two sub-classes, Gamopetalæ and Choripetalæ. — Goebel's Outlines, p. 467.

The Stamens.

Let us review the flowers we have studied with special reference to the stamens, in order to become acquainted with their various forms and the terms employed to describe them.

We have always told first the number of the stamens and then stated whether they were distinct or united. We find that all the flowers we have studied have distinct stamens, except the House-Geranium and the Abutilon, where there is a staminal tube. Such stamens are *monadelphous*, from two Greek words meaning "in one brotherhood." This form of stamens is characteristic of the whole Mallow family.

Sometimes the stamens are united by the anthers. We shall see examples of this in the Violet, the Dandelion, and, in fact, all Composites.

The insertion of the stamens is a very important point in description. They may be inserted on the receptacle, or a receptacular disk, on the calyx, or on the corolla. There are three words used to describe their insertion, two of which

we have already mentioned in connection with the corolla. They are important words to learn and to remember, because they are used a great deal in classification. We have employed them to divide our polypetalous flowers into three groups. These words are *hypogynous*, *perigynous*, and *epigynous*. The stamens are hypogynous when they are inserted on the receptacle, beneath the ovary, like the stamens of the Tulip, the House-Geranium, the Abutilon, etc. They are perigynous when they are inserted on the calyx, or on a disk made by the growing up of the receptacle around the ovary. We shall soon have examples of this union in the Rose family. They are epigynous when they are inserted on the calyx or corolla on top of the ovary, or on a disk formed by the growing up of the receptacle entirely around the ovary. The Fuchsia, the Begonia, and the Snowdrop are examples of flowers with epigynous stamens. Sometimes the stamens are inserted on the corolla (*epipetalous*).

Stamens are usually made up of *filament* and *anther*, but the filament, being only a stalk, is

not an essential part of the stamen. When there is no filament, an anther is said to be *sessile*, just as a leaf without its stalk is sessile.

The anther is filled with *pollen*. We have already learned its use. It is to fertilize the ovules in order that seeds may be formed.

Anthers are generally two-lobed, or as they are called, rather incorrectly, two-celled.[1] Almost all the flowers we have studied have two-celled anthers, but those of the Abutilon, as in the Mallow family in general, are one-celled.

The *connective* is the continuation of the filament, connecting the two lobes of the anther. When this connective runs up between the anther cells the anther is *innate*. In this case it is attached by its base to the apex of the filament, and turns generally neither in nor out. The Begonia has innate anthers (Fig. 6, 4).

Anthers are *adnate* when the cells are fixed

[1] **Each of these so-called cells is made up of a pair of pollen-sacs, united longitudinally, and the commonest mode of dehiscence is the splitting of the anther lobe up and down the edge of the partitions of the two pollen-sacs, while the tissue of these partitions is torn away, so that the pollen of both sides is discharged at the same time. All such anthers are really four-celled. See Goebel, p. 369.**

throughout their whole length to one side of the connective. We have not had any example of this form. We shall see it later in the Violet (Fig. 10, 3, 4). When the anther is fixed by a single point to the filament it may face inward (*introrse*), or outward (*extrorse*), or it may swing loosely back and forth, in which case it is *versatile*.

These forms are governed by the necessities of the flower. In flowers adapted for insect visitors, the position and form of the anthers is always such that the pollen will be rubbed off by the insects.[1] If the nectar is in the centre of the flower between the stamens and the pistil, so that an insect is obliged to creep within the staminal circle to get at it, we should expect to find introrse anthers. On the other hand, if the nectar is at the base of the perianth, or so situated that the only access is outside of the sta-

[1] A wider statement may be quoted from Goebel. The modes in which the pollen-sacs dehisce are very various, and have a close and constant relation to the rest of the arrangements for pollination in the flowers whether by insects or some other means. Outlines of Classification and Special Morphology of Plants, p. 368.

mens, we should look for extrorse anthers. This must be taken as a statement with many exceptions, as there are flowers with special arrangement for the affixing of the pollen to the insect where the rule would not apply, such as the Violet and the Milkweed. But it is certainly true that this principle of adaptation is one that can be generally traced by thoughtful study of the relations between the insect visitors and the flower, and that the grasping of this idea renders the study of forms, that is, morphology, fascinating. Thus, in a flower like Tropæolum, for instance, we do not think that it is sufficient to note that it has eight distinct stamens with erect anthers, but we observe how the stamens rise one by one and place themselves in the path to the nectar, and when they have risen discharge and become a round mass of pollen, so that no visitor to the spur can fail to be dusted with the yellow grains.

The description of the anthers is a difficult point, especially for the beginner, but it has been made rather unnecessarily puzzling by our text-books.

By far the larger number of flowers with which we have to deal have anthers which are neither innate nor adnate, such as the Hyacinth, the Crocus, the House-Geranium, and many others. These anthers are fixed at a single point to the apex of the filament, and may be either introrse or extrorse.[1] They cannot be called versatile, unless they swing loosely, as in the stamens of a lily. We have in our text-book no term to describe them. If we take the terms used by Bentham and Hooker, and divide anthers into two classes, those fixed by the back (*dorsifixed*), and those fixed by the base (*basifixed*), we shall have little difficulty. Dorsifixed anthers may be either introrse, extrorse, or versatile.

It should always be remembered, however, that these terms are only our attempts to describe the things we are classifying, and that the anthers, as well as all other organs of the plant, are perfectly independent of our definitions, and have no scruples at all about spoiling

[1] **An anther may be extrorse when young and introrse when old, as in the Spring Beauty (*Claytonia*), or *vice versa*.**

them in any given case. Thus, for instance, in the anthers of the Horsechestnut blossom, the cells are continued below the insertion on either side of the filament. When the anthers are young the cells are parallel with the connective and the anthers appear to be basifixed, but later they swing forward, and any one would say that the anthers were fixed by the back. Every classification must be held subject to exceptions and somewhat plastic. Beginners always wish to make their definitions a sort of Procrustean bed, into which every natural object must be made to fit by lopping or stretching. The truer view is to regard Nature as having a language of her own, which cannot be completely expressed in ours, but must miss many fine shades of meaning when translated into words. The universe was not created to be parcelled out into little groups of objects, each with its own label, as many teachers seem to think, although, undoubtedly, it would be much easier for us to teach, if this were the case.

The *dehiscence* of an anther is the mode in which it splits to discharge its pollen. The

most common way for it to split is up and down the whole margin. This is *longitudinal dehiscence.* The anthers of the Tulip, the Begonia, the Tropæolum, and, in fact, nearly all the anthers we have examined, discharge in this way. The Snowdrop anther only splits a little way down and discharges through a small slit near the top of each cell, although there is a line all down the margin. The Azalea anther discharges through little round pores in the top of each anther cell. This is a character that distinguishes the Heath family, with some exceptions, to be noticed later.

The pollen consists of grains, which differ in different plants.[1] A compound microscope is necessary to study their structure. See the text-book, Gray's Lessons, p. 103.

Gray's Lessons, 281–299.

[1] Reader in Botany. III. Protection of Pollen.

IV.

EARLY SPRING FLOWERS.

WHY do certain flowers bloom so early in the spring? A few warm days are enough to send the flower-buds above ground and to unfold the blossoms even before the leaves. How is this rapid growth possible?

HEPATICA TRILOBA.[1]

If in very early spring we dig up an Hepatica root, we find a bit of rootstock with a cluster of dried leaves, and in their centre a bud. A piece of the rootstock of Bloodroot, Solomon's Seal, Skunk Cabbage, and many other spring plants, will also show the buds ready to unfold. A comparison of these buds with the better known buds of the trees will be very instructive. The reason for the rapid spring growth is the same

[1] Appendix, p. 299.

in both cases. The season's growth is prepared during the previous summer, and the leaves and flowers are packed away in an advanced state of development, with a neighboring store of food in the stem, so that the flowers can mature without waiting for the new leaves to assimilate nourishment for them.

If we compare buds of Elm or Maple with the buds of Hepatica or Bloodroot, we shall see that both are surrounded by scales. We saw in the buds of the trees that the scales in each species were arranged on a certain definite plan, corresponding to the arrangement of the branches, because they were, in fact, modified leaves.[1] So it is with our herbs. The Hepatica has the scales arranged on the plan of three, the Bloodroot on the plan of two.

The true leaves of the Hepatica (Fig. 7, 6) alternate with the scales (*d*, *e*), and in the axils of the scales we find the flowers (*c*), indicating that the flower is a branch, for branches are developed in the axils of leaves. In the centre we find a tiny bud (*a*), which is the beginning of

[1] Part I, pp. 69, 72.

the growth for the next season. The ground plan of the whole bud is here given (Fig. 7), the parts represented in cross section, just as we made a ground plan for a single flower in our first lesson.

In the section on buds we gave the definition, "a bud is an undeveloped branch."[1] Therefore this whole plant of Hepatica, when developed from the bud, is a branch from the underground stem, and the flowers, being in the axils of leaves, are also branches. We may give the definition of a flower, "a flower is a branch modified for the production of seed."[2] It follows that the parts of the flower are modified leaves. This will be brought out more fully in after lessons, and the teacher must use his own judgment whether it shall be dwelt upon early or late in the course. A lesson of this kind is very instructive, for it enables the

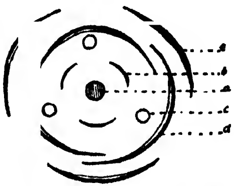

FIG. 7.—Ground plan of year's growth of Hepatica.

[1] Part I, p. 55.

[2] See Concerning a Few Common Plants. By G. L. Goodale. Boston, D. C. Heath and Co., 1888. Pages 28, 42.

pupils to grasp firmly the principles of morphology, and later, will help them to unravel many puzzles.

In the axils of the scales are the flowers, which are also arranged on the plan of three (Fig. 8, *B*, 1). If the buds are placed in water the flowers will quickly develop and we can study them more easily. The stem does not develop, but the leaves appear to come from the root, and are therefore termed *radical*. Each flower-stem, which also appears to come from the root, is called a *scape*.

The flower has an involucre of three green bracts, which every scholar will call a calyx (Fig. 8, *B*, 2). The real calyx, which they will mistake for the corolla, is of six, or more, blue, purple, or white sepals, and within this are many stamens. In the centre is a head of many separate carpels. All these circles are separate from each other, and the parts of each circle are distinct. The plan of three can be traced in the green bracts and the sepals, which are normally six in number.

It would be better if we could begin our study

of the spring flowers with a flower like the Buttercup, which has a calyx and corolla, instead of with an Anemone, lacking its corolla, or an Hepatica, with its calyx-like involucre, but our lessons must be adapted to practical needs, and the Buttercups are so unkind as to refuse to blossom till Anemones are scarce and Hepaticas have departed. We shall soon see why we regard the outer circle of the Hepatica as an involucre, rather than as a calyx.

The Hepatica is one of the very first and most charming of our wild flowers. The little fuzzy buds seem to be protected against the cold by their furry garments. The flowers appear before the leaves, but we can find last year's leaves for our descriptions. The nourishment for the growth of the flowers is stored in the rootstock, and the flowers do not have to wait until the leaves have made enough food for them to grow, as is the case with the later spring flowers, which have no storehouses of food, or have only leaves packed away in their winter buds.[1]

[1] Reader in Botany. IV.

The buds of Bloodroot are arranged on the plan of two. The scales are in pairs and do not alternate, as usual. There is a pair of leaves, opposite the scales, and the flower is in the centre. The bud for the next year is in the axil of a leaf, instead of being terminal, as in the Hepatica. It may be helpful also to compare a Tulip bulb, where the modified leaves contain the food, and the flower is in the centre. All these buds, the buds of the trees, of the herbs, and the bulb, which is only a fleshy bud stored with nourishment, are made up of a succession of plant individuals, each containing the node, internode, and leaf (*phyton*).[1]

When the internodes develop the plant has a stem; when they do not develop the leaves are crowded and seem to come directly from the root. In the Bloodroot and Hepatica the internodes do not develop.

WOOD-ANEMONE (*Anemone nemorosa*).[2]

The Anemone has a single radical leaf, which is palmately compound. It has also a flower-

[1] Part I, p. 44. [2] Appendix, p. 300.

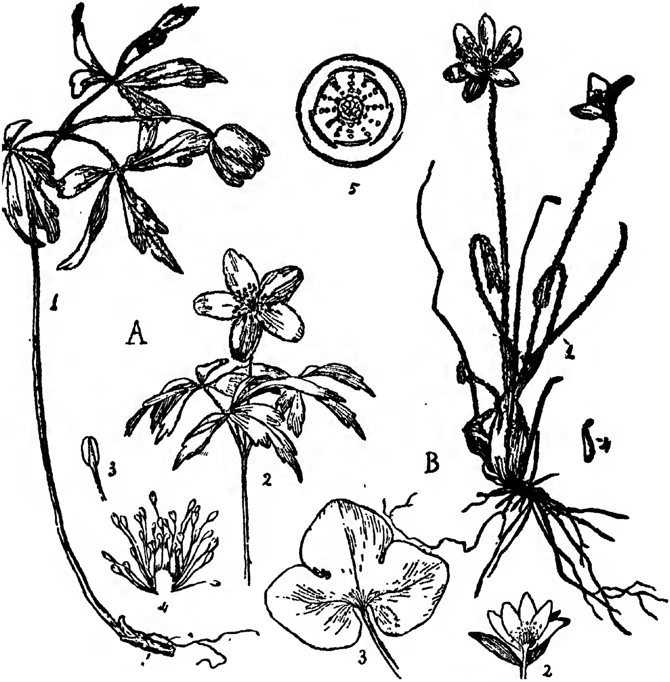

FIG. 8. — *A*. Wood-Anemone: 1. Whole Plant. 2. Open flower. 3. Stamen. 4. Stamens and carpels. 5. Diagram. *B*. Hepatica: 1. Whole plant. 2. Section of flower. 3. Leaf. 4. Carpel.

bearing stem, with a circle of three compound leaves answering to the primary divisions of the radical leaf (Fig. 8, *A*, 1).

The flower is evidently incomplete. Ask the pupils what they can find in the Anemone that corresponds with the green bracts of the Hepatica. Perhaps some of them will point out the stem leaves of the Anemone and be pleased with the discovery. If the principles of the chapters on Buds and Seedlings have been well assimilated, they will not be surprised to see how leaves can be modified into widely differing forms.

The scholars could not tell for themselves whether to call the flower-leaves of the Anemone calyx or corolla. When one circle is wanting it is generally, but not always, the corolla. We determine the question, in the case of the Anemone, by comparing it with other nearly related flowers. In some flowers of the same family the petals are very small and the sepals large and petal-like, as in the Gold-thread (*Coptis trifolia*) and the Hellebore. The next step is for the petals to become very minute, as in a

European Isopyrum, and then to disappear altogether, as in an American Isopyrum. The sepals remain and they are petal-like and assume the functions of the corolla in attracting insects. If the teacher can have dried specimens at his command to illustrate such points as this he will find them of great assistance.

The Hepatica resembles the Anemone so much that many authors place them in the same genus and call the flower *Anemone Hepatica*. By analogy, then, we see that the seeming corolla of the Hepatica answers to the calyx of the Anemone, and that the three green leaves outside it are bracts corresponding to the stem-leaves of the Anemone.

A *bract* is the modified leaf belonging to a flower-cluster, and a circle of bracts is called an *involucre*. We shall find this word applied to the stem-leaves of the Anemone, and the bracts of Hepatica are described as a calyx-like involucre.

The stamens and pistil of the Hepatica and Anemone are very similar. The anthers are a good illustration of innate anthers (Fig. 8, *A*, 3).

The carpels are one-seeded and do not split open when ripe (*indehiscent*). This form of fruit is called an *akene* (Fig. 8, *B*, 4).

MARSH-MARIGOLD (*Caltha palustris*).[1]

This is an excellent flower for beginners, being so simple and so large. There are no radical leaves. The stem is hollow and furrowed, and the leaves are clasping and have thin papery stipules joined to the stem. The flowers are terminal and in the axils of the upper leaves.

The flowers strongly resemble the last two we have examined, with one important difference. The carpels are many-seeded instead of containing but one seed, and they split open when ripe. This kind of fruit is called a *follicle*.

The nectar is secreted by the carpels in the little folds on the inner side. The carpels, after splitting, often become strongly recurved, so that they resemble the petals of a flower. They then show very clearly that they are really modified leaves. They are, of course, not to be

[1] Appendix, p. 301.

seen in this stage at the season when we are studying the flower, but we use them later as an illustration of the theory of the flower.

Early Meadow-Rue (*Thalictrum dioicum*).[1]

Another early spring flower belonging to the same family as the Anemone, Hepatica, and Caltha, is the Meadow-Rue (*Thalictrum dioicum*). The sexes are separate in this plant. A single flower consists merely of the four or five sepals and a head of stamens or of carpels. The staminate and pistillate flowers are on different plants (*diœcious*).

When a flower has essential organs of one kind only, that is, when the stamens and carpels are on separate plants, it is called *imperfect.* We have already had a specimen of an imperfect flower in the Begonia. The staminate flowers of the Begonia resemble the Meadow-Rue, but the pistillate flowers are wholly different. In the former the ovary is inferior and the carpels are united, in the latter they are akenes.

These flowers ought to be fully described.

[1] Appendix, p. 302.

Each flower should be taken for a separate lesson, and the pupil should describe it as fully as his age and knowledge will permit.

We will compare short descriptions of these flowers and we shall find that they differ much less than in the other comparison that we made.

HEPATICA.

Calyx.	Corolla.	Stamens.	Pistil.
5 sepals, polysepalous.	None.	Many, distinct on receptacle.	Several carpels, distinct, one-seeded, free.

ANEMONE.

Calyx.	Corolla.	Stamens.	Pistil.
5 sepals, polysepalous.	None.	Many, distinct on receptacle.	Many carpels, distinct, one-seeded, free.

CALTHA.

Calyx.	Corolla.	Stamens.	Pistil.
5 sepals, polysepalous.	None.	Many, distinct on receptacle.	5–9 carpels, distinct, many-seeded, free.

MEADOW-RUE.

Calyx.	Corolla.	Stamens.	Pistil.
4 sepals, polysepalous.	None.	Many, distinct on receptacle.	4–15 carpels, distinct, one-seeded, diœcious

We see that these flowers all agree essentially in their structure. They are therefore very nearly related, and we shall find on referring to our schedule that they all belong to the first family, the Crowfoot family (*Ranunculaceæ*). The flowers are dicotyledons, polypetalous, and the parts are inserted under the ovary and all distinct.

There is no better practice for the judgment than in this comparison of plants, seeing how they may be classified in groups, the closest relation being a species (though this is sometimes divided into varieties), the next grouping being into genera, and less close degrees of relationship being expressed by the division into families and classes.

In the little description given above we see that no distinction is made between Anemone and Hepatica. The seeming calyx of one answers to the three-leaved involucre of the other, and the structure of the essential organs is the same.

The Caltha differs in its carpels being follicles instead of akenes. The Meadow-Rue has separated sexes, but otherwise closely resembles the

rest, and a very nearly allied flower, formerly placed in the genus Thalictrum, but now known as *Anemonella thalictroides*, is so much like the Anemone, that it is known as Rue-anemone.

We shall study other flowers later which belong to the *Ranunculaceæ*, but differ greatly in form. Relationship is shown more clearly in the structure of the essential organs than in the floral envelopes, because the latter are more subject to modification from the visits of insects and other external causes.

Bloodroot (*Sanguinaria Canadensis*).[1]

An early flower that is in every way excellent for study is the Bloodroot. Give the pupils buds as well as flowers, or he will think the flower is incomplete like the Anemone, or else that the outer circle of the corolla is the calyx. The calyx is *fugacious;* it drops off even before the flower opens.

It is not difficult to see where the flower got its common name. The orange-red drops of juice always appeal to the imagination and remind us

[1] Appendix, p. 303.

of the old tales of imprisoned nymphs. We seem to see the life oozing away as we pick the flowers. If the scholars can dig up their specimens for themselves, try to make them observe where the plant had thrown up its shoot the year before, and from where next year's bud will spring. It is a good opportunity for a little review of rootstocks and underground stems.

The leaves are very interesting. They are radical and come up in a roll with the flower-bud within (Fig. 9). This always delights the children. Sometimes we find the flowers in pairs. Close to the ground and beneath it are the scaly, papery bracts which sheathe the season's growth. How our hands look after we have been picking the flowers!

We have noticed the fleeting calyx. The corolla is made up of beautiful pure white petals in two or more circles. When there are two circles they alternate, but the petals belonging to the third circle halve the distance between the others. The inner petals are a little smaller. The petals are separate and are free from the other parts of the flower (Fig. 9, 4).

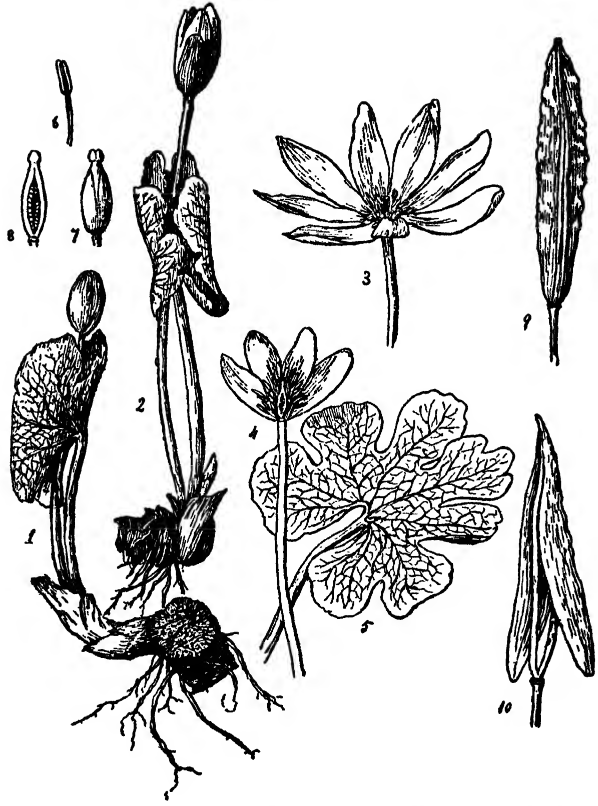

Fig. 9. — Bloodroot. 1, 2. Whole plant. 3. Open flower. 4. Vertical section. 5. Leaf. 6. Stamen. 7. Ovary. 8. Vertical section of ovary. 9. Pod. 10. Pod, after dehiscence.

The stamens are many, distinct, on the receptacle. The anthers are innate (Fig. 9, 6).

The pistil is of two united carpels, making a one-celled ovary, with the ovules on the walls (Fig. 9, 7, 8). This is *parietal placentation*. There are two parietal placentæ and a sessile, two-lobed stigma.

The pod of the Bloodroot splits between the carpels, leaving the placentæ behind. The two pieces which split away are called *valves* (Fig. 9, 9, 10). The seeds are crested.

Where does the Bloodroot belong on our schedule? It is a dicotyledon and polypetalous, and the petals are under the ovary. The parts are all distinct too, except that the pistil has its carpels united, so we must look for it near the beginning of our schedule. The flowers are regular, the parts in twos and fours, the ovary one-celled, and the ovules on its walls. We place it, therefore, in the Poppy family (*Papaveraceæ*). Other characteristic points that mark the family are the sessile stigmas and the fugacious sepals.

SPRING BEAUTY (*Claytonia Virginica*).[1]

The root of the Claytonia is from a small, deep tuber. There is no great difference between a tuber and a rootstock. A *tuber* is a thickened rootstock with buds upon it; the Potato is the most familiar example.

The upper part of the stem is simple and has one pair of opposite leaves. The inflorescence is a loose, terminal raceme. We had an example of a raceme in the Hyacinth, which was very densely flowered. A *raceme* is a cluster in which the flowers are arranged on pedicels on a common stem, with the youngest flowers at the top, The whole flower-stalk is called a *peduncle*, and the stalk to each flower is a *pedicel*. Other examples of racemes are Lilies of the Valley, Solomon's Seal, and Wild Cherry.

The stamens mature before the style, as in the Tropæolum and Pelargonium. After discharging their pollen, they bend back closely against the corolla, and the branches of the style which are stigmatic on the inside open. Hence the flower is cross-fertilized.

[1] Appendix, p. 304.

The ovary is of a different type from any we have seen. There are three carpels, but the ovules are neither on the walls nor in the middle, but rise from the base.

The flower is a dicotyledon, polypetalous and hypogynous. It therefore belongs near the beginning of our schedule. It belongs to the Portulaca family, distinguished by the regular flowers with two sepals, five petals, and one-celled pod with the ovules rising from the base. A very common weed belonging to this family is the Purslane, or "pusley" (*Portulaca oleracea*), hated of gardeners.

The Pistil.

The word pistil is used in two ways. For example, in a flower with separated carpels, like the Anemone, the term pistil may be applied to each separate ovary with its style and stigma, or to the whole seed-bearing portion of the flower (*gynœcium*). In the first case the Anemone would be described as having many pistils. In the second case it would be said to have a pistil of many distinct carpels. Dr. Gray uses the former

method, but I have preferred the latter, because I have found it more simple.[1] In thus departing from our text-book we shall create great confusion, unless the point is made perfectly clear.

A pistil is made up of carpels, just as the calyx is made up of sepals and the corolla of petals. As in the calyx and corolla the parts may be distinct or united, so in the pistil the carpels may be distinct, when the pistil is termed *apocarpous*, or united, when it is *syncarpous*. As a flower is a branch, the sepals, petals, stamens, and carpels are modified leaves. This theoretical explanation of the flower is for some classes a help at the start, and for others more helpful as a conclusion reached after a good deal of study. On this point the teacher must exercise his own judgment.

[1] In the method adopted here the word pistil is taken to mean the whole seed-bearing portion of the flower. It therefore includes all the carpels; and corresponds in usage to the term calyx, including the sepals, corolla, including the petals, and *andrœcium*, including the stamens. In Dr. Gray's method, the term pistil includes a single carpel, or all the carpels, according to whether they are separate or united. The term carpel always represents a single modified leaf, and corresponds in usage to the terms sepal, petal, and stamen.

A pistil is either *simple* or *compound*. It is simple when it consists of a single carpel. So far, all our pistils have been compound; that is, they have consisted of two or more carpels. But in some of them the carpels are united, as in the Tulip, Tropæolum, Begonia, etc., and in others distinct, as in the Anemone, Hepatica, and Caltha.

The parts of a complete syncarpous pistil, or separate carpel, are ovary, style, and stigma, and of these parts only the ovary and the stigma are essential. The ovary is essential, because it holds the seeds, and the stigma is necessary, because through this part of the pistil the pollen tubes descend to fertilize the ovules. "Its form is very variable and is always closely connected with the way in which the pollen is conveyed to it, whether by insects or other means, and can only be rightly understood by reference to these circumstances."[1]

The ovules are borne generally on the edges of the carpels. A *placenta* is the place which

[1] Goebel's Outlines of Classification and Morphology of Plants, p. 380.

bears the ovules. The placentæ may be either on the walls of the ovary (*parietal*) or in the centre (*central* or *axile*).

A good way to illustrate these various forms of the pistil and to show how they may be formed from single carpels, is to give the scholars leaves to represent carpels and to ask them to put them together to make a pistil. Let us take several leaves, double each one together, turning the margins inward, and fasten them to our receptacle separately. We have then the arrangement of the pistil of the Caltha, remembering that the ovules are borne on the incurved margins of the leaf. That is an apocarpous pistil. Now take two leaves and place them together by uniting their margins. We shall then have a one-celled ovary of two carpels, with the placentæ on the walls. It will be a pistil of two united carpels, with a one-celled ovary with two parietal placentæ. We have an example of this in the Bloodroot (Fig. 9). Now let us double the leaves together, as in the first case, and then unite them by their joined margins. We then have a com-

pound pistil of two carpels with a two-celled ovary and a central placenta. As there is a row of ovules on each margin of the carpel, we should normally have two rows of ovules in each cell. We have not had a flower with a pistil exactly like this, but if, instead of two, we take three carpels, we have the arrangement of the Tulip, the Hyacinth, the Snowdrop, the Crocus, and the Begonia.

There is still another thing that we can do. We can join the carpels for a little way only at the base. We have an example in the Spring Beauty, which has three carpels with the ovules rising from the base. In some of the Pink family the carpels are united to the axis below, while they are free above, but in some genera of this family the ovules are probably produced directly from the axis, not from the united edges of the carpels.[1] This free column, holding the ovules, while the carpels form a closed

[1] This is a much disputed point. See note in Gray's Structural Botany, p. 267; also Goebel's text-book, pp. 375–377. The latter says there are genera in the *Caryophylleæ* in which it is more probable that the placenta is axial (that is, belonging to the axis); others where it seems to belong rather to the carpels.

ovary about it, makes a *free central placenta*, of which we shall have examples in the Chickweed and other members of the *Caryophyllaceæ*.

All the flowers we have been considering have a closed pistil (*angiospermous*). The Pines, however, have an open pistil. We can represent it by taking an open leaf, and imagining it to bear one or more ovules near the base. The scales of cones are such open carpels and the seeds they bear are developed from naked ovules. There is no stigma at all and the pollen is blown directly to the ovules. Such a pistil as this is called *gymnospermous*.

The nature, position, and form of the ovule is rather a difficult subject for the beginner and it is best to touch it lightly. The various terms employed in the description will be found in the text-book.

Gray's Lessons, 300–322.

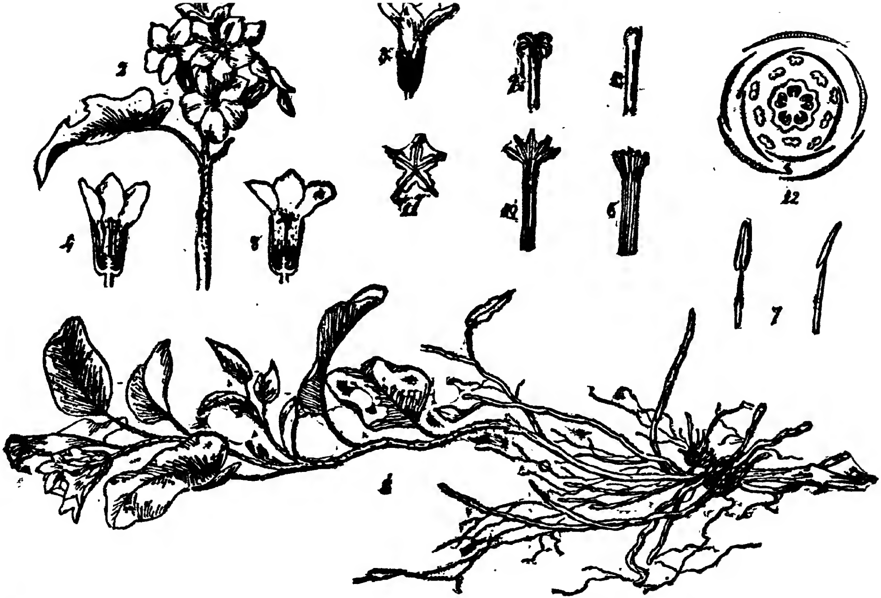

Fig. 10. — Trailing Arbutus. 1. Whole plant. 2. Flower-cluster. 3. Single flower. 4. Section of sterile flower. 5. Style of sterile flower. 6. Same laid open. 7. Stamen. 8. Section of fertile flower. 9. Style of fertile flower. 10. Same laid open. 11. Same, seen from above. 12. Diagram.

V.

EARLY SPRING FLOWERS.—*continued.*

MAYFLOWER, TRAILING ARBUTUS (*Epigæa repens*).[1]

THIS plant is not very fitly named, for it comes to us in April, and in most seasons the first of May finds it on the wane.

It is a wonderfully beautiful flower in its structure, as well as when we look at it from an outside point of view.

The plant is woody, trailing and creeping, and covered with rusty brown hairs (Fig. 10, 1).

In our Manual the flower-clusters are described as axillary, but they are really terminal (Fig. 10, 2). Each flower is surrounded with an involucre of three or four bracts (Fig. 9, 3).

The inside of the corolla is thickly covered with fine, soft hairs, which may serve to protect

[1] Appendix, p. 307.

the nectar from the rain, and perhaps to keep out unwelcome visitors.

The flower has two forms in its stamens and style. One kind of style has five short stigmas and looks almost club-shaped (Fig. 9, 4, 5, 6). In another flower the five stigmas are long and spread widely out like a little star (Fig. 9, 8, 9, 10, 11). The top of the style spreads out into a five-lobed ring or collar beneath these lobes. In the flowers with long stigmas the stamens are apt to be short and generally without anthers. This would indicate that they are the fertile flowers, and such has been found to be the case. I have occasionally found flowers where the stamens were entirely suppressed. In flowers with short stigmas the stamens are more often long (Fig. 9, 4, 7).

Dr. Gray says that there are two lengths of style, and that each kind of stigma is found on both the long and short styles. This would make four kinds of flowers. If it were the rule that there were no stamens in the flowers with long stigmas, the flower would be diœcious. If the two lengths of style always corresponded to

the two lengths of stamens the flower would be dimorphous.[1] But it is not exactly either.

My observations on the flower differ from Dr. Gray's, in that I have never seen a flower with a short style.[2] Once I found an apparently perfect flower with long stamens and long stigmas. The flower evidently varies in different localities.

This is a very interesting case, for it shows a flower which is on the way to become either diœcious or dimorphous, and is not perfectly adapted to either mode of cross-fertilization. It is evident that the conditions are not favorable to fertilization, as the flower seldom sets seed. Here is an opportunity for the pupils in any New England country town to do some real investigating, for the flower is very imperfectly understood. There are regions in which the

[1] Dr. Halstead in notes on Epigæa repens, in the Torrey Bulletin, for August, 1891, says that the dimorphism of the flower is not far advanced, for there is no difference in the size of the pollen of the short and long stamens, as is found in truly dimorphic flowers.

[2] American Journal of Science and Arts, July, 1876, p. 74. See also Lester F. Ward. American Naturalist, XIV, p. 198.

Mayflower habitually sets seed, and I am inclined to think that in almost any locality the capsules could be found by careful search. The flowers are all alike on the same plant, so far as I have examined, so that flowers young enough to show the structure of the stamens might be found on a seed-bearing plant, or might be marked and studied from year to year.

There is a difference also in the size and appearance of the flowers. The fertile ones are smaller and do not open quite so widely.

The anthers of the Mayflower are different from the typical anthers of the Heath family. We saw in Azalea that these dehisced from little holes in the top of the cell. The anthers of the Epigæa dehisce longitudinally. The whole look of the plant, the rusty-hairy stem, leathery leaves, and so forth, would tell any one accustomed to classify plants that it belonged to the Heath family (*Ericaceæ*).

The Epigæa is a very instructive example of the fact, too often forgotten, that the evolution of new forms of flowers is not a completed

process, but that the same causes that have produced changes in the past are producing them to-day.

Common Blue Violet (*Viola cucullata*).[1]

We seem to have waited a long time before taking up our dear spring flower which is found everywhere and which every one loves, the Violet. But the flower is not so fleeting as the Anemone and the Bloodroot, and will wait till we have time to examine it carefully at our leisure. If we pull up the common blue Violet, we find that it has, as so many of our spring flowers have, an underground stem. This stem is a thick rootstock with fleshy teeth. The teeth are the traces of leaves. We know this from seeing how the new shoots spring from their axils.

The leaves have very large stipules. We have had no plant, as yet, with such striking stipules as this.

The calyx has separate sepals with lobes produced backward, which are called *auricles*.

The corolla has a spur on the lower petal.

[1] Appendix, p. 308.

We know from our study of the Tropæolum what its use may be. If we cut off the end of the spur and pinch it, we shall see the nectar oozing out. There is not much nectar in the spring Violets; we can find a great deal more in the cultivated Pansy. Whatever markings the flower has lead to the spur, and are followed by the insects. These nectar-guides are much more conspicuous in the Pansy than in most of the common Violets.[1]

The two lower stamens have appendages which project into the spur (Fig. 11, 3), while the three upper stamens are without them (Fig. 11, 4). These spurs of the stamens secrete the nectar, which runs down into the little pocket ready to receive it. The hungry insects find the nectar ready for them there. But we know that they have to pay for their meal by carrying pollen to another stigma. How is this accomplished?

Looking carefully at a flower, we see that the anthers are joined to the inner face of the filament, and that each filament is extended beyond

[1] Notes on the fertilization of the Wild Pansy will be found in Nature, Vol. VIII, pp. 49, 50, 121, 143, and 202.

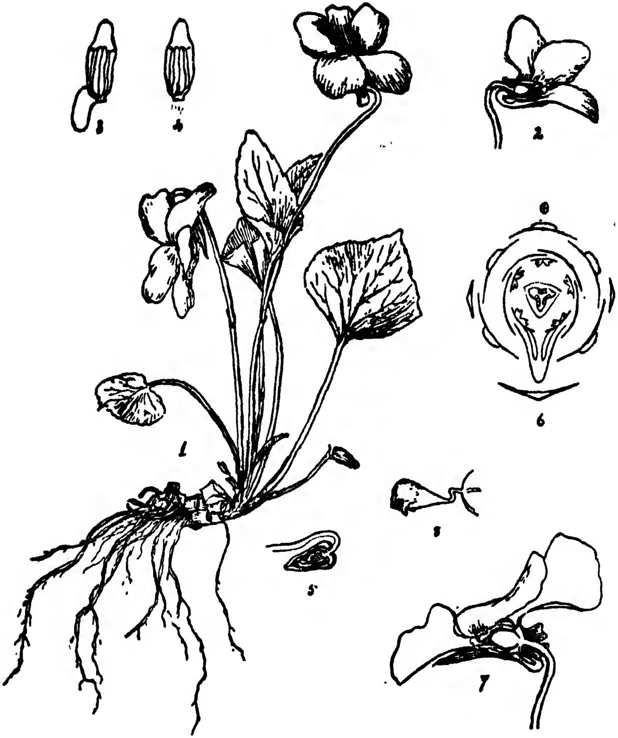

FIG. 11. — Common Blue Violet. 1. Whole plant. 2. Section of flower. 3. Lower stamen. 4. Upper stamen. 5. Cleistogamous flower 6. Diagram. 7. Section of Pansy. 8. Style of Pansy.

its anther (Fig. 11, 3, 4). We describe them by saying that the anthers are adnate and introrse. The filaments are in a ring pressed closely together around the style (*connivent*), and the lateral petals have a thick fringe of hairs, so that there is no entrance to the nectar anywhere except through a little furrow in the lower petal, which leads directly into the spur. If we watch a bee at a Violet, we see that he alights on this lower petal, and thrusts his proboscis down this furrow. Imitate this action with a hairpin, or any sharp instrument. The anthers are thrust apart, and some of the pollen is left on the pin. When the bee comes out, he does not leave any of this pollen on the stigma, because there is a lip beneath the round stigmatic cavity which prevents him from touching the stigma in going out. When, however, he flies into another flower, he hits the stigma in going in.

We can see this better in the cultivated Pansy (*Viola tricolor*), where the parts are larger, and there is a more distinct lip to the stigma. The arrangement is shown in Fig. 11, 7, 8. The

stigma is a hole filled with a sticky fluid, and just beneath it is a shelf, or lip. The style has a twist at the base, and is flexible, like a hinge, and the stigma is lateral, just beneath the tip of the style. When the bee goes into a flower his head touches the sticky stigma, but when he comes out his head hits the shelf and turns the stigma upward, so that he does not touch it.[1] We can easily experiment with any sharp instrument, and see how prettily the lip acts in turning the stigma out of the way when the tool is drawn out.

Alfred Bennett in the article in Nature, referred to in the note on page 92, thinks that the Wild Pansy, or Hearts-Ease, is fertilized by tiny thrips rather than by bees. Observations of the insect visitors of the cultivated Pansy, or any of the wild Violets, will be interesting.

It seems rather strange that, after all this delicate mechanism to secure cross-fertilization, the Blue Violet should not produce most of its seeds in its conspicuous flowers. If we pull up a whole plant and examine its base, we shall

[1] Lectures on the Physiology of Plants. Sachs. Page 794.

find flowers which look like small green buds. One of them can be seen on the plant in Fig. 11. A vertical section of one of these buds, placed under the lens (Fig. 11, 5), will disclose an ovary full of ovules, surmounted by a hooked style, and surrounding it, two stamens with possibly rudiments of others, and perhaps a petal or two. This is a closed flower which never opens, but ripens its seeds in the dark. The pollen-grains send out tubes to the ovary without leaving the anther. In the Blue Violet these closed flowers produce most of the good seeds of the plant.[1] They are called *cleistogamic* or *cleistogamous* flowers. They occur also in some species of Oxalis, in the Touch-me-not (*Impatiens*), and one of our Polygalas. Many of them are subterranean and ripen their seeds beneath the ground. A list will be found of the species containing cleistogamic flowers in Darwin's Forms of Flowers.[2]

[1] Reader in Botany. V. Close-fertilized Flowers.

[2] The Different Forms of Flowers on Plants of the Same Species. By Charles Darwin. New York, D. Appleton & Co., 1887. Page 310.

The Violet has three carpels and there are three parietal placentæ in the one-celled ovary. The placentæ are peculiar in covering the whole surface of the carpels instead of the margins only. Many species of Violet throw their seeds by a contraction of the edges of the carpels when the pod splits open. The Blue Violet is said to do this.

The Violet belongs among the first families on our schedule, as it is a dicotyledon and polypetalous, with hypogynous corolla and stamens. The family is distinguished by its irregular, one-spurred corolla, the adnate, introrse, connivent stamens, and the one-celled pod with three placentæ on the walls.

Bluets, Innocence, Quaker Lady, Blue-eyed Babies, Bright-eye (*Houstonia cærulea*).[1]

The number of common names for this widely spread little flower would indicate that it has been loved by many generations of children. Where it grows it is often found in great abun-

[1] Appendix, p. 309.

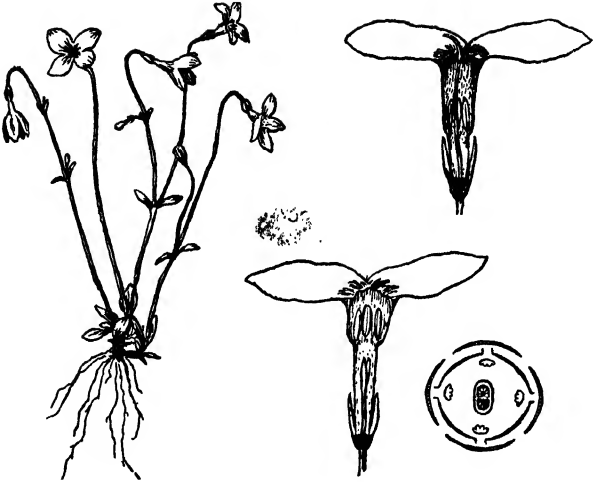

Fig. 12. — Houstonia cærulea. 1. Whole plant (reduced). 2. Long-styled flower. 3. Short-styled flower (magnified). 4. Diagram.

dance, covering the meadows with a white carpet. It is a peculiarly delicate and refined flower, as the names show. Beginners will find it too small to examine very satisfactorily, except in the more obvious points.

The inflorescence is determinate; each flower ends the stem, and there are one or two side peduncles from the nearest axils bearing younger flowers. This inflorescence is called a *cyme*.

The colors of the corolla vary a good deal, some flowers being nearly sky-blue and others shading gradually down to white. The parts of the flower are in fours.

The flower is an excellent example of a *dimorphous* condition of style and stamens. Let the pupils examine a number of flowers very carefully and sort out those which are exactly alike. Some of them will show the stamens in the throat, and some the two-parted style. Making vertical sections we find the state of things represented in Fig. 12. Darwin has proved that such flowers are fully fertile only when the long-styled flowers are fertilized with pollen from the long stamens, or the short style receives the

pollen from the short stamens.[1] We have another example of a dimorphous flower that can be generally obtained in the Bouvardia of our greenhouses.

The ovary is inferior. We place the flower, therefore, in the first part of our gamopetalous division. It has opposite leaves and the stamens are as many as the lobes of the corolla. This might seem to belong either to the Honeysuckle or to the Madder family, but it has stipules, which places it in the latter. The Bouvardia belongs to the same family. The Partridge-Berry belongs here also, and it is very common in this family to find dimorphous flowers.[2]

Dog-Tooth Violet (*Erythronium Americanum*).[3]

If you ever tried to dig up a Dog-Tooth Violet you will certainly begin by writing in your description, "Root fibrous from a *very deep* bulb." How this root comes to be so deep I do not know; whether it is gradually drawn into the

[1] Forms of Flowers, pp. 132, 254. Chapter VI sums up the general conclusions on heterostyled plants.

[2] Reader in Botany. VI.

[3] Appendix, p. 311.

FIG. 13. — Dog-tooth Violet. 1. Flower-stalk. 2. Base of stem and root. 3, 4. Flower. 5. Flower with five leaves and two stamens removed. 6. Diagram.

ground by the contraction of the underground stem, or whether, as the new bulbs are formed beneath the old ones (Fig. 13, 2), it is only in a series of years that the bulb becomes so very deep. This is a good subject for investigation. The leaves are mottled. They are radical and sheathe the base of the one-flowered scape, the first leaf being wrapped quite around the second.

In the flower we recognize that we have got back to the plan of three (Fig. 13, 4, 6), and if we have already noticed that the leaves are parallel, we shall say that we have probably a monocotyledon. The flower is very easy to describe, but there are some points about it which might be overlooked. The petals have a callous tooth on each side near the base, and the style has generally, but not always, a twist at the base that reminds us of the Pansy (Fig. 13, 5).

If we examine a good many flowers we shall find some with yellow and some with red-brown stamens. I suspect that one of these kinds is fertile and the other sterile, but I have never seen the subject treated, and it would be a good one for the pupils to investigate. Let them

cover certain plants with gauze to keep out insects and leave others free, having marked the colors of the stamens by tying different colored threads around the plants. In this way they can find out whether cross-fertilization is necessary, and, if so, by artificial fertilization they can discover which flowers are fertile.

Another point of interest is the large number of plants which do not flower in comparison with those that do. When the plants are transplanted this tendency is increased. I have never been able to make them flower in cultivation. I do not know why this is so.

The pupils ought to have no difficulty in placing this flower in the Lily family, after the lessons on the Tulip, Hyacinth, and allied flowers.

The ovary is superior, the parts of the perianth colored alike, and the stamens six in number.

STAR-FLOWER (*Trientalis Americana*).[1]

This flower is often found growing beside the Wood-Anemone, and as children, we used to call it Star-Anemone, from its resemblance.

[1] Appendix, p. 305.

The rootstock is very slender, long, and creeping. It throws up simple, erect stems, which bear a few scattered leaves below and a crowded, whorl-like cluster at the summit. The flowers spring from this cluster and terminate the stem, either singly, or several together. They are on slender stalks and are very delicate.

They are star-shaped, with a flat, spreading corolla, and stamens opposite its lobes. The stamens have slender filaments and oblong anthers, which roll up after flowering. The ovary has a *free central placenta*, a column in the middle bearing the ovules, unconnected with the sides of the ovary.

We shall place the flower among the gamopetalous families with superior ovary and regular corolla. We may know the Primrose family (*Primulaceæ*) by the opposite stamens, and the free central placenta.

VI.

THE FOREST TREES IN BLOSSOM.

We have seen that the reason why certain flowers, as Hepatica, Bloodroot, and Epigæa, are able to develop before the leaves, is that the buds are already in a high state of development, and need only the warmth and moisture of spring to complete their growth. The food is already stored in rootstock and stem. This development of the flower-buds during the previous summer may explain why fall flowers of these spring plants are sometimes found.

The flowers on early blossoming trees are also prepared and packed away in the buds during the previous season. Examining these trees, we are struck at once by the great number of them with the flowers arranged in long, scaly spikes called catkins. The Willow, Poplar, Birch, Hazel, Alder, Oak, Walnut, Hornbeam, Beech,

Pine, Larch, and many others are so arranged, at least as to the staminate flowers. There is a good reason for these long, drooping clusters of stamens. All these trees, with a single exception, the Willow, are fertilized by the wind. The catkins are swayed by every breeze, and when the pollen is in the right state, clouds of the fine yellow dust are borne away when we shake them. The pollen is light, abundant, and smooth, and the flowers are not colored or scented to render them attractive to insects.

If the dense screens of leaves were developed before the blossoms, they would interfere very greatly with the pollen reaching the fertile flowers. The flowers of the Chestnut, it is true, develop after the leaves, but the conspicuous tassels hang at the very ends of the branches where they are blown to and fro, and the fertile flowers are above these clusters.

In wind-fertilized trees where the flowers are not grouped in catkins the stamens generally hang out on long, drooping filaments, or the flowers are on long, slender pedicels. The wind-fertilized flowers of grasses are always carried

up in the air above the surrounding mat of foliage.

The wind-fertilized, unisexual flowers of the trees just mentioned are of a lower type than the flowers we have been studying. On our schedule they are placed among the apetalous flowers, and we shall find most of them in the group, "flowers in catkins." Another large group that we shall glance at are the Evergreens. They belong to the class of Gymnosperms, or naked-seeded plants. The ovules in this group are naked, and are borne on an open carpel, which is sometimes wanting.

We will now study some of the trees in detail.

WILLOW (*Salix*).

The Willow is one of the earliest growing things to put forth its buds. We may even find the downy catkins bursting from the scales in February. Some kinds of willows put forth their blossoms before the leaves in April, some with the leaves in May. Some even blossom in June after the leaves are fully developed, so that we can study them at almost any time during the spring.

The Willows are high trees or low shrubs, with long, tough roots, flexible branches, tough bark, simple stipulate leaves, and flowers in terminal clusters, or lateral from the axils of the leaves of the preceding year. The pupils have probably often noticed the flexibility and elasticity of the twigs, and have utilized this property for switches and as a substitute for cord. Most children have woven willow twigs together for baskets or some other childish use. An interesting property of the Willow is its capability of growth from cuttings. Twigs which fall to the ground from the trees sometimes take root and grow. The tree possesses wonderful vitality, and when cut down the stump is soon covered with a thick growth of new twigs which grow rapidly into strong branches. Surely every country child has made its playhouse in some such old gnarled tree. How often too we have tried in vain to break one of the twigs and learned experimentally the extreme toughness of the inner bark.

The flowers of the Willow grow in long, close, bracted clusters, with one flower under each bract, or scale. These clusters are called *cat-*

kins, or *aments*. There are two kinds of catkins, staminate and pistillate, which are found on different plants.

One kind of flower has generally two stamens; the other kind consists of a pistil of two carpels. Each flower is covered by a bract, and has a gland at the base (Fig. 14, *a*). This is all that can be found in the flower. There is nothing answering to calyx or corolla. The pupils may ask why the bract does not represent one of the floral envelopes. By this time they should be accustomed to reasoning from analogy, and the question is answered by explaining that the Birch and Alder catkins have three or four flowers under each corresponding bract.

FIG. 14. — Staminate and pistillate flowers of Willow.

The Willow is very attractive to bees, which suck the nectar secreted by the glands. Going from tree to tree, they carry the pollen on their bodies to the stigmas of the pistillate flowers and thus fertilize them. Although the Willow is fertilized by insects, most of its near relatives are fertilized by the wind.

The fruit of the Willow is a one-celled pod, opening by two pieces or valves, and discharging its very numerous seeds. The seeds are covered with a plume of long silky hairs (*coma*), and the effect when the pods are opening is very beautiful. This silky tuft serves the purpose of making the seeds fly away from the parent plant, and gives them a better chance to grow. We shall see many adaptations for scattering seeds.

The different kinds of Willow are very difficult to distinguish; they hybridize easily, and it is quite out of the question for a beginner to attempt to refer them to their species. For this reason we have spoken of the whole genus instead of taking a special example.[1] It is enough that we have an example of an apetalous flower, with the flowers in catkins and one flower under each bract. This will place it in our schedule under *Salicaceæ*, the Willow family. We will compare it with the Poplar, the only other genus belonging to this family.

The flowers of the Poplar are also arranged

[1] But a description of *Salix Petiolaris* will be found in the Appendix, p. 312.

with both kinds of flowers in catkins and one under each bract, but the Willows have entire bracts and nectar glands, while the Poplars have cut-lobed scales and no nectar glands, and are, as we should expect from the absence of nectar, wind-fertilized. They require, therefore, many more stamens than the Willow (for the waste of pollen in wind-fertilized flowers is much greater than where the pollen is carried by insects), and the stigmas are elongated, so that they may the better catch the pollen. The whole Willow family have catkins enclosed during the winter in scaly buds, but in the Willow they are covered with a single scale, and in the Poplar with several or many scales. The Willow (*Salix*) and the Poplar (*Populus*) are the only genera belonging to this family.

Another very important family in this apetalous group with the flowers in catkins is the Oak family (*Cupuliferæ*). The sixth edition of the Manual places the Birches in this family and divides it into three tribes, the Birch tribe (*Betuleæ*), the Hazel tribe (*Coryleæ*), and the Oak tribe (*Quercineæ*). This family may be dis-

tinguished from the Willows by being monœcious. The leaves are simple in both.

The first tribe is represented by the Birch and Alder. The sterile flowers of the Birch are in long, drooping catkins, densely flowered and sessile, terminal and in the axils of the upper leaves of the preceding season. The fruiting catkins are smaller, terminal on short branchlets with a distinct peduncle, erect or slightly drooping. The sterile catkins are formed in the previous season and remain naked all winter; the fertile are enclosed with two leaves in a scaly bud.

Each bract of the catkins is shield-shaped and tipped with brown. Within are two smaller bracts, and opposite each of these three bracts is a scale, bearing two deeply-parted filaments. Each division of the filaments bears an anther-cell, and there thus appear to be twelve one-celled anthers, four to each scale. The morphology of this group of flowers is difficult and quite impossible for a beginner to make out. The scales represent the remains of floral envelopes, and each flower consists of a calyx of one scale, bearing two deeply-parted filaments.

The fertile flowers are naked, and consist only of an ovary, with two diverging stigmas. There are two or three under each bract. The fruit is a winged nut. The different species of Birch are easily recognized by their bark.

The Alder catkins resemble the Birch greatly. The sterile catkins are axillary, the fertile clustered at the ends of the branches. There are generally three flowers beneath each bract, and each flower has a calyx of four scales as well as several bractlets. The fertile catkins have a calyx also, and this, with the bractlets, becomes woody in fruit and remains on the shrub in little persistent cones.

The last group, the Hazels, contains the Hazel, Hop-Hornbeam, and Hornbeam. This group has no calyx. The stamens are generally forked, bearing an anther cell on each fork. The fertile flowers are two under each bract, and have beside one or two bractlets which make an involucre to the nut.

The fertile flowers in the Hazel are in terminal clusters. They have a number of bracts at the base of the cluster, and the flowers are in

the axils of the upper bracts, and seem to consist wholly of the long, red stigmas, which hang out, making a little red tuft at the top. Looking at the base of the stigmas we cannot see any ovary. It develops later, and is surrounded by an involucre, formed of the two leafy bracts.

The Hop-Hornbeam is a common tree which is very conspicuous in fruit. It flowers at the same time as the Birch and Alder, and is excellent for comparison with them. The sterile catkins resemble those we have been studying very closely, having several stamens in the axil of each bract. The fertile flowers are in short catkins, in terminal leafy buds, a pair under each bract. They are enclosed in a bractlet, which becomes a sort of bladdery bag, and makes a cluster very like that of the Hop, whence the name of the tree. The tree is distinguished readily from the Hornbeam by the furrowed bark. The bark of the Hornbeam is smooth.

The flowers of the Hornbeam are very similar, but the bracts of the sterile flowers are deciduous and the bractlet is open in fruit, instead of being a closed bag.

The involucre is a very conspicuous part of the fruit in all this tribe. In the Hazel it makes, as we have seen, a leafy involucre for the nut; in the Hop-Hornbeam it is a closed bladdery bag; in the Hornbeam it is open, but no less conspicuous.

In the last tribe, the Oak tribe, we have three genera, the Oak, Chestnut, and Beech. We will study the Red Oak.

Red Oak (*Quercus rubra*).[1]

If we look at a flowering branch of the Red Oak, we shall see the long, drooping staminate catkins in the axils of the leaves of the preceding season, and lateral on the bases of the new leafy shoots; we shall also find in the axils of last year's leaves below the clusters of stamens, small round heads of bracts, crowned by little, hard, dry, three-lobed projections. We are apt to mistake these for the pistillate flowers, but on a more thorough search we find the true fertile flowers in the axils of this year's leaves. They are tiny blossoms with three red

[1] Appendix, p. 313.

stigmas, surrounded by tightly appressed bracts. What, then, are the larger bodies below? Our pistillate flowers are in the axils of the lower leaves of the season, these are in the axils of the lower leaves of the preceding season. The pistillate flowers have three stigmas, these have three dry lobes at the top. They are evidently last year's fruit. Let us look further back on the branch. Perhaps we may find some acorns, and these will also be in the axils of former leaves, but always of at least two seasons before. The fruit of the Oak, therefore, takes two years to ripen, and the bodies we have been examining are fruits during their first year, before they have matured. The acorn is the fully developed fruit, and we shall find it, also, crowned with the persistent stigmas, while the involucre of appressed scales has become the saucer-shaped acorn cup. The acorn is a one-seeded fruit, the rest of the ovules never maturing.

The staminate flowers of the Oak are very simple, consisting of a three-lobed calyx and four to six sessile stamens. They are in long, drooping clusters on slender, naked peduncles,

the bracts falling off before the flowers open (*caducous*).

Some of the Oaks, the White Oak and its nearly allied species, mature their acorns in the first year, and these Oaks can be distinguished by the rounded lobes and sinuses of their leaves, which are never bristle-pointed.

Another important family of the apetalous group, with the flowers in catkins, is the Walnut family (*Juglandaceæ*). The trees of this family are monœcious, like those of the Oak family, but the leaves are pinnately compound instead of simple, and have no stipules. The sterile flowers are in naked catkins, the fertile solitary or clustered. The Walnuts (*Juglans*) and Hickories (*Carya*) belong to this family.

American Elm (*Ulmus Americana*).[1]

The blossoms of the Elm are among the first to show themselves, while the leaves develop later than in most trees. The blossoms are apt to be so abundant that it surprises us to see the

[1] Appendix, p. 314.

leaves budding so long after we have observed the tree dressed in a spring suit.

The flowers are in thick clusters from axillary buds in the axils of the lower leaves of the preceding year (Part I, Fig. 16). They are on slender pedicels, which are short when the flower first opens, and gradually become long and drooping. The flowers are perfect, but the pistil does not develop into fruit in all of the flowers.

The calyx is a little oblique cup, often delicately tinted with red. There is no corolla, and we shall, therefore, look for the tree in the apetalous division. The fruit is a samara, winged all around, two-celled, or one-celled by the non-development of one of the cells, and forming a one-seeded fruit.

The Elm tribe is the only one in its family (*Urticaceæ*) where the flowers are perfect, all the others being monœcious or diœcious.

We will study a few trees with complete flowers, before passing to the consideration of the Gymnosperms, or naked-seeded plants, and first we will glance at the Maples.

Red Maple (*Acer rubrum*).

The Red Maple is one of the first of our trees to blossom, and by the time the Birches and Hazels are in full flower we can find only the forming fruit. The flowers are small, with a five-parted, reflexed calyx and five linear petals, which are folded towards the centre of the flower. The stamens vary in number. The ovary is two-celled with a wing from the back of each cell, which greatly enlarges in fruit and converts the fruit into a double samara or pair of keys.

The petals and stamens are inserted on an hypogynous disk. The fruit does not develop in all the flowers and the anthers do not discharge their pollen in the fertile flowers, so that the sexes are really separate. The tree is monœcious or diœcious. We find many trees without fruit, while others are laden with it, and it seems to me it is becoming entirely diœcious.

The Sugar Maple is very conspicuous in spring from its long, drooping filaments, which give

the tree a beautiful appearance, as if covered by a soft mist.

The flower of the White Maple (*A. dasycarpum*) is without a corolla. We see from such cases that our distinction between the polypetalous and apetalous divisions is a very artificial one. For this reason the modern German authors place the apetalous families among the polypetalous ones. We cannot fail to see, as we study more of nature, that all such classification is purely a matter of convenience.

The Norway Maple (*A. platanoides*)[1] is now a common tree in cultivation, and will supply a very good subject for study and comparison with our native Maples. The flowers are larger and therefore easier for beginners, and it flowers later. If the flowering time of the other Maples has passed, this will be available.

The tree is spreading, with large, smooth, bright green, not very deeply incised leaves (Fig. 15, 2). It flowers in May.

The flowers grow in terminal clusters. The primary branching is indeterminate, while the

[1] Appendix, p. 316.

secondary branches have the flowers in cymes. They begin to appear before the leaves (Fig. 15, 1), and the cluster continues to enlarge and develop more blossoms until the leaves are well grown.

The flowers are about half an inch wide. The calyx is gamosepalous, adnate to a fleshy disk around the ovary, on which the five petals and the eight stamens are inserted (Fig. 15, 3). The disk secretes nectar. There are different forms of flowers on the same tree with two lengths of stamens. The flowers with long stamens (Fig. 15, 3) have pistils which never mature, and the short stamens (Fig. 15, 4, 5, 6) never open to discharge their pollen, so that the flowers are really completely separated as to the sexes, and are dependent on the visits of insects or the wind for their fertilization, as is also the case with all our other species of Maple. The long, pendulous stamens of the Sugar Maple impress us with the idea that the pollen is intended to be carried by the wind. I do not know whether this is the case.

The ovary is two-lobed, two-celled, winged on

FIG. 16. — Norway Maple. 1. Flowering branch. 2. Leaf. 3 Section of sterile flower. 4, 5, 6. Fertile flower in successive stages. 7. Fruit. 8. Diagram.

the back of each cell, and from this wing of the ovary grows the wing of the fruit (Fig. 15, 6, 8). The fruit is a double samara, and the halves separate when the fruit is ripe (Fig. 15, 7).

The Soapberry family (*Sapindaceæ*), to which the Maples belong, we shall find on our schedule between the hypogynous and perigynous divisions, for the stamens and petals are inserted either under or around the ovary. The family contains only shrubs and trees, with the stamens and petals inserted on a fleshy disk either beneath or around the ovary. The seed is exalbuminous. This family contains also a tree common in cultivation which is an extremely interesting study, the Horsechestnut.

HORSECHESTNUT (*Æsculus Hippocastanum*).[1]

We have already made a thorough study of the growth of this tree.[2] The flowers are as interesting as the buds, and will repay a careful examination.

The flower-clusters are terminal. Each cluster is a *thyrsus;* that is, a dense compound

[1] Appendix, p. 317. [2] Outlines, Part I, pp. 54–68.

cluster, in which the primary branching is indeterminate, while the inflorescence of each branch is determinate, the terminal flowers first developing. We can easily see that the lower branches are the first to develop, and that therefore the whole cluster is indeterminate, but the branches appear to be also racemose, as the youngest flowers are at the end of each branch. This cannot really be the case, however, for the flowers are all on the same side of the branch (Fig. 16, 1). The lowest flower opened first and was originally the terminal flower; then a lateral branch, also terminated by a flower, arose from its pedicel, and this process went on, till there were perhaps eight flowers in the cluster. The process is the same as that of the growth of the leafy branch of the tree, where the stronger axillary bud threw its fellow to one side, making it appear lateral instead of terminal.

There are many flowers on a single thyrsus. The primary branches average about twenty-five on my tree, with an average of eight flowers on a branch. There are more flowers on the lower branches, for the reason, I suppose, that

FIG. 16. — Horsechestnut. 1. Flower-cluster. 2, 3. Staminate flower. 4. Stamen. 5. Rudimentary pistil and four stamens of staminate flower. 6. Pistillate flower. 7. Cross section of ovary. 8. Diagram.

they appear sooner and have time to develop more lateral branches. The first flowers to develop are all staminate, having a rudimentary pistil only (Fig. 16, 3, 5). Later, other flowers with perfect pistils, the style protruding from the unopened bud (*proterogynous*), appear (Fig. 16, 6) and still later ones are again generally staminate. The pistillate flowers have perfect stamens, which discharge. Müller mentions a case, like the one that we discovered in the Norway Maple, of the stamens in the fertile flower never discharging. I have never seen this happen.

The calyx of all the flowers is gamosepalous and five-lobed, adnate to an hypogynous disk which secretes nectar. The corolla is polypetalous, of four or five (Fig. 16, 2) petals. When there are but four petals the lower one is absent. The petals have claws and two projections where the blade joins the claw. These projections are pressed tightly against the stamens, and perhaps serve to protect the nectar from the rain and to close the path to creeping insects. The color of the petals is white with yellow nectar-guides, which are chiefly on the

two upper petals and change gradually to a beautiful crimson. The color of the whole cluster is therefore prettily variegated, the older flowers having crimson, the younger yellow spots, with varying shades of color according to the age of each flower. This change of color seems to answer the purpose of informing the bees which flowers are old and rifled of their nectar. I have never seen a bee creep into a crimson-spotted flower.[1]

The entrance to the nectar is at the base of the two upper petals, the path below being cut off by the projections on the petals and the position of the stamens.

The stamens are usually seven, distinct, at first declined. The stamens rise one by one when mature (Fig. 16, 3), as in Tropæolum, and like that also in a definite order. If we are looking at the right time we can see the anther of a stamen which has just risen split suddenly and become covered with pollen. When this takes place, the anther is directly in the path to the nectar.[1]

[1] Reader in Botany. VIII. The Horsechestnut.

It is very clear that a bee entering the flower would brush against the stamens and become dusted with pollen, and would leave this pollen on the style of the next pistillate flower visited, for the style curves upward and stands in exactly the same relation to the path to the nectar as do the stamens while discharging. The honey-bees have a wicked way of crawling about under the flowers and stealing the nectar from beneath, but the bumble-bees appear to visit the flower always in the proper way.

The pistil of Horsechestnut has three united carpels. The ovary is three-celled, with an ovule in each cell. It is covered with glandular hairs (Fig. 16, 7), which become the prickly bristles of the bur. Generally only one of the ovules develops into the beautiful seed with its shining brown coat, which is so dear to the children, but sometimes we find two, and occasionally three, packed away in the bur, side by side.

The embryo in the seed is large and fills the whole shell. The caulicle has a nice little pocket of its own in the hard seed-coat.

The gradual development of the fruit and the stiffening of the soft hairs into prickles is a very interesting study. The prickly bur is a protection for the nuts, which, although so bitter, are eaten by some animals.

A very interesting adaptation in the Horse-chestnut is the presence in the buds containing flower-clusters of well-developed axillary buds in the axils of the upper leaves. These grow at once, and while the flower-cluster is still young become rapidly growing branches, while the leafy branches, without flower-clusters, have merely latent buds in the axils. The intention to carry on the branch when the flower-cluster drops off is evident, but how does the branch know what is coming? Is it because the development of the flower requires less nourishment?

Gymnosperms.

Finally, we have the Gymnosperms, or naked-seeded plants, very many of which are in flower in early spring. The study of these flowers is too difficult for the ordinary beginner to pursue very successfully, but it may be profitable to

point out certain interesting peculiarities of the Coniferæ.

The Larch (*Larix*) is very beautiful in May, with its delicate new bundles of soft needles, the only deciduous tree among all our native Coniferæ. The fertile flowers are of a clear crimson color, and in the European Larch are very large and handsome.

The fertile and sterile flowers are found on the same tree. The sterile flowers consist of little brown clusters of stamens. They are lateral on the branches, and replace the leaf-buds, so that there is a space without leaves in each year's growth, exactly as we saw in the Elm.[1] They are surrounded with scales which answer to the scales of a leaf-bud. The accepted view of them is that the whole cluster is a single flower with the stamens arranged spirally on the axis. The anther cells open across the anther.

The fertile flowers are at the ends of short branches, generally with leaves in the bud also. They are almost globular, of a brilliant red color, the scales imbricated in a dense cone.

[1] Outlines, Part I, p. 81.

These scales are open carpels, bearing two ovules on the base of each scale. The whole is regarded as a single flower by some botanists, and by others as a catkin of flowers, each scale representing a single flower. The former view is the one adopted by Goebel in the new edition of Sach's text-book.[1]

In early spring we often see the Red Cedar or Savin (*Juniperus Virginiana*) covered with a golden light.

> "Red cedars blossom too, though few folks know it,
> And look all dipt in sunshine like a poet."

If we examine them we shall find the tips of the branches covered with tiny tassels of stamens, so full of pollen that when we shake the tree a yellow cloud is borne away by the wind. The scale of each group, which we may regard as a shield-shaped filament, bears from three to six anther cells, attached to its lower edge.

[1] "The whole flower is long and conical and resembles a catkin in outward appearance, and is, in fact, termed a catkin in the superficial language of many systematic botanists, though the amentum of Dicotyledons is an inflorescence while the apparent catkin of the Coniferæ is a single flower." — Goebel's Outlines, p. 323.

On another tree we shall find the fertile flowers, which are so small and so much like the leaves that a long search may be necessary. They are very tiny bluish rosettes of scales, with one or two bottle-shaped ovules at the base of each scale. The scales swell in fruit, become fleshy, and unite about each ovule and with each other, forming a blue berry with small projections which show the former tips of the scales.

The leaves of the Savin are of two sorts. One kind is very closely appressed, imbricated, short, and scale-like; the other sort is longer, larger, and looser. These leaves are on different branches.

The Yew (*Taxus Canadensis*) blossoms somewhat later. The connective is lobed, and makes a sort of little cup or inverted umbrella over each group of anther cells. The fertile flowers, almost always on another plant, have a solitary ovule, surrounded with a receptacular disk, which is cup-shaped and becomes red and pulpy, surrounding the seed in the fruit.

The Arbor Vitæ (*Thuja occidentalis*) has conspicuous little cones at the ends of its branches.

The flowers of the season are globular, with pointed, fleshy scales, bearing two erect, bottle-shaped ovules at the base of each scale. These scales spread when they are dry and remain as the persistent cones.

The staminate flowers resemble those of the Red Cedar, and have scale-like connectives bearing four anther cells.

The leaves of the Arbor Vitæ are of two sorts, on different branches, one short, blunt, and joined to the branch, the other loose and awl-shaped.

Later in the season, early in June, blossom the Pines. We will examine in particular the Pitch Pine (*Pinus rigida*).[1]

This is a tree with a very rough bark and a wild, scrubby appearance. The wood is hard and very resinous.

The leaves are of two sorts. The primary leaves are scale-like, thin, brown, and closely appressed to the branch. In their axils are produced the clusters of needle-shaped leaves which make the foliage of the tree (Fig. 17). These

[1] Appendix, p. 319.

leaves are evergreen, long and narrow, rounded without, angled within, in bundles or *fascicles*, which in this species consist of three needles, in the White Pine five, and in the Red Pine two. They are surrounded at the base with thin scales.

Early in spring the new shoots appear, and around the base of these is a cluster of staminate flowers (Fig. 17, 1), which appear long before the fertile flowers can be seen, but do not mature till they are ready to receive the pollen.

The staminate flowers consist of scale-like filaments, spirally arranged on the axis. To the under side of each scale the two anther-cells are attached (Fig. 17, 2, 3).

The fertile flowers are lateral on the shoots of the season, sometimes solitary on the shoot, sometimes with two or more in a cluster (Fig. 17, 4).

They consist of open scales, each thickened at the apex, with a sharp, recurved point, becoming a prickle in the cone. The two ovules are sunk in the base of the scale (Fig. 17, 5, 6, 8).

Some botanists regard this cone as a catkin of separate flowers; others (the view adopted

here) look upon it as a single flower.[1] Each ovule-bearing scale is apparently in the axil of a bract, so that the cluster would seem to be a catkin. But it does not seem exactly natural to regard the staminate "catkins" as single flowers, and the pistillate cones as a cluster of flowers. Goebel regards the small bract as the true carpel, and the large, ovule-bearing scale as a placenta, which has outstripped in its growth the carpel that bore it.

One noticeable thing about all these trees is their adaptation for wind-fertilization. The pollen is extremely light, fine, and abundant, so abundant in many cases that the wind or a

[1] The observation of very young cones of Abies pectinata shows that the seminiferous scale arises as a protuberance on the base of the so-called bract-scale (cone-scale) and therefore is not axillary. While the latter subsequently grows very little or not at all larger, this outgrowth from it increases greatly in size and produces on its upper surface the two ovules, which adhere to it by one side and turn their micropyles to the axis of the cone; the seminiferous scale of these genera must therefore be regarded as a *placenta* of large dimensions, growing out of a carpellary leaf, the latter being naturally small or stunted in its growth. The whole cone is therefore a single flower with numerous small, open carpels, usually termed bract-scales, which are far outstripped in growth by their seed-bearing placentas, the seminiferous scales. — Goebel's Outlines, p. 328.

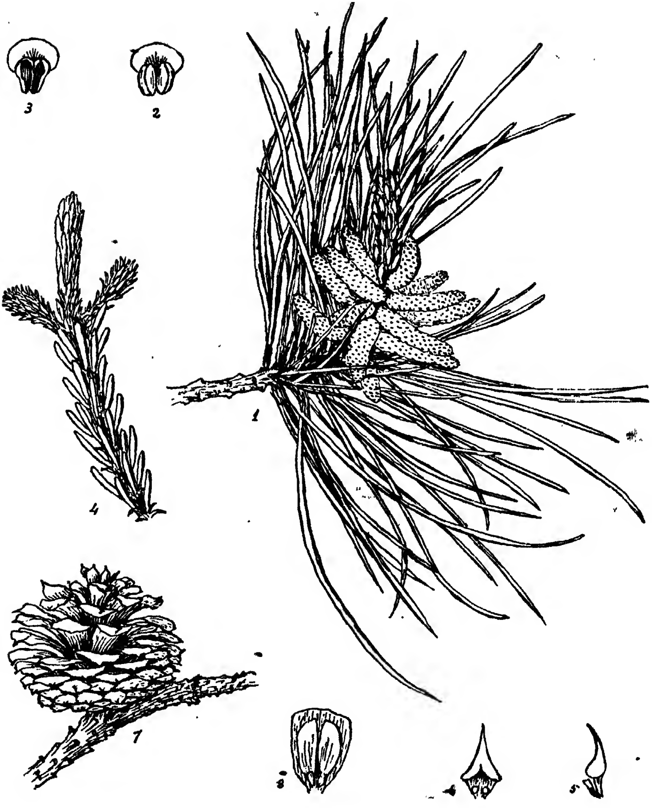

Fig. 17. — Pitch Pine. 1. Branch with staminate flowers. 2. Single staminate scale. 3. Same, the pollen-sacs dehisced. 4. Shoot, with fertile flowers. 5. Fertile scale, seen from the side. 6. Same in front. 7. Cone. 8. Single scale, with fruit.

slight shaking of a tree bears away clouds of yellow dust which looks like sulphur.

Nearly all of them have some receptacle into which the pollen may fall until a good gust comes to bear it well out into the world, instead of being dissipated by falling at once on the ground. This receptacle is generally formed from the upper side of the scale-like filament, which is immediately under another anther, and makes a sort of cup to hold the pollen. This receptacle is very striking in the Yew.

All these plants belong to the Pine family (*Coniferæ*), the only family of the Gymnosperms represented in our native plants. The Pine family is composed of trees and shrubs, with, in most cases, evergreen, needle-shaped leaves. The flowers have no floral envelopes and naked seeds, and the sexes are separated.

We must not forget that the Gymnosperms occupy an intermediate position between the Flowering Plants (*Phanerogams*) and the Flowerless Plants (*Cryptogams*), and that it is possible to regard them from another point of view from the one we have just set forth.

There is a difference in terminology between these two great divisions of plants, and we may treat the Gymnosperms from the cryptogamic standpoint, if we wish. But I fear we shall have to establish a new race of young pupils, before macrosporangia and microsporangia, microspores, and sporophylls will be as intelligible as ovules, anthers, pollen-grains, and stamens. It is desirable, however, to call the attention of the pupils to the fact that the plants we have been discussing may be described and studied from two standpoints, from above and from below.

VII.

BLOSSOMING FRUIT-TREES AND THEIR ALLIES.

THERE is no more attractive study than the blossoms of the fruit-trees. If it is now the end of April the Cherry trees are probably white with blossoms. Let us bring some of the flowers into the class and study them.

CHERRY (*Prunus Cerasus*).[1]

The flowers are from axillary buds, in the axils of the leaves of the preceding season. There are only one, two, or three flowers in each bud, but the buds are very close together and the flowers are often in large clusters, with the young leaves in the centre (Fig. 18, 1).

The flower is regular and complete. The calyx is gamosepalous and free. On the throat

[1] Appendix, p. 322.

of the calyx are inserted the five petals of the corolla and the many distinct stamens. They are not inserted beneath the ovary, but around it, and are therefore perigynous (Fig. 18, 2). The ovary is superior, of one carpel, and contains two ovules (Fig. 18, 4).

Apple (*Pyrus Malus*).[1]

The Apple blooms later than the Cherry, but the blossoms can be very easily forced by bringing branches into the house. The Pear (*Pyrus communis*) will answer equally well for comparison with the Cherry, and blossoms somewhat earlier than the Apple. Another flower that may be substituted for the Apple is the *Cydonia Japonica*, better known as Pyrus Japonica, or Japan Quince, which blooms at the same time as the Cherry.

The Apple blossom is larger than that of the Cherry, and more showy, the corolla being beautifully tinged with pink.

The stamens are like those of the Cherry, and are inserted with the petals on the throat of the

[1] Appendix, p. 320.

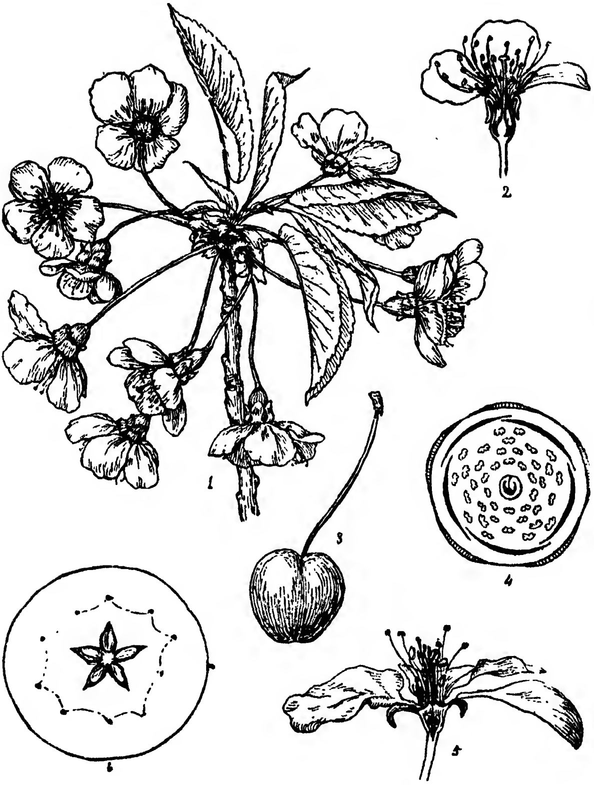

Fig. 18. — Cherry. 1. Flower-cluster. 2. Section of flower. 3. Fruit. 4. Diagram. 5. Section of Apple Blossom. 6. Cross section of an Apple.

calyx, but the calyx, instead of being free, is united to the ovary, and the ovary has five cells and two ovules in each cell. We shall notice the fruit later.

STRAWBERRY (*Fragaria Virginiana*).[1]

This presents another type. The calyx is similar to the others, but it has also five bractlets, alternating with the calyx lobes. The corolla and stamens, like those of the Cherry and the Apple, are on the throat of the calyx. The calyx is free, as in the Cherry, but there are many carpels, in a head, on an enlarged receptacle (Fig. 19, 2). The styles are lateral (Fig. 19, 3) instead of terminal. Each carpel contains a single ovule, and does not split open; it is an *akene*.

The Strawberry is an herb, with an underground rootstock. It throws out long, slender stems above ground, which root at a distance from the plant and form new individuals. Such long, rooting stems are called *runners* (Fig. 19, 1).

There could not be a better exercise in classi-

[1] Appendix, p. 323.

fication than these members of the Rose family afford. A plan, which has proved successful, is for the pupil to make descriptions in parallel columns of representatives of several important tribes of the Rose family, such as the Cherry, representing the *Pruneæ* (the Almond tribe), the Strawberry, representing the *Potentilleæ*, and the Apple or Pear as types of the *Pomeæ*. If the Rose and Spiræa are also added, we shall have examples of five of the seven tribes to be found in the sixth edition of the Manual. In earlier editions, we shall find that the Rose family is divided into three divisions, called the Almond, the Rose, and the Pear sub-orders, and that the three blossoms just described represent these three divisions. In the Appendix will be found a schedule, describing the Cherry, Strawberry, and Apple in parallel columns.[1]

It is usually possible, by taking the latest specimens of the Cherry and the first blossoms of the Strawberry and Apple, to have all in bloom for the same lesson. By a little search in a greenhouse, we can find specimens of the Rose

[1] Appendix, p. 367.

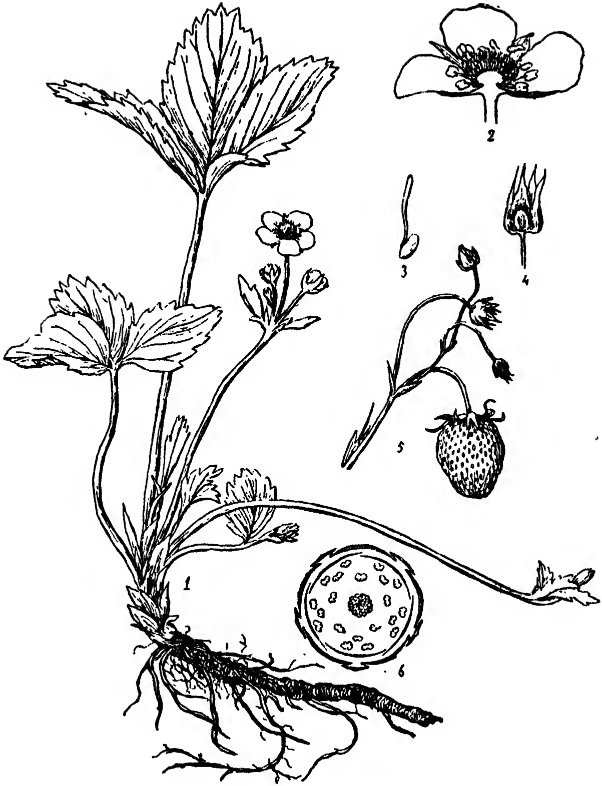

FIG. 19. — Strawberry. 1. Whole plant. 2. Section of flower. 3. Carpel. 4. Section of head of carpels and calyx. 5. Fruit. 6. Diagram.

that have not lost all their essential organs. The Bon Silene rose is one of the best. In many of our gardens there are early blossoming Spiræas.

We might multiply examples of easily obtainable members of the Rose family. The Peach and Plum, with the various Wild Cherries, belong to the genus Prunus, the Potentilla and Avens (*Geum*) belong to the *Potentilleæ*, and the Shadbush (*Amelanchier*) and Hawthorn have a compound ovary consolidated into a single body with the calyx, and belong to the *Pomeæ*. The Blackberries and Raspberries, belonging to the tribe *Rubeæ*, begin to blossom in May, but the members of the Poterium tribe do not arrive till the middle of summer.

Let us now look more in detail into these various tribes of the Rose family.

The first group, *Pruneæ*, needs, perhaps, no more explanation. The ovary of the Cherry is *simple;* that is, it consists of only one carpel. We can see by the furrow on one side of a cherry where the margins of the carpellary leaf meet (Fig. 18, 3). The Double Cherry has apparently two carpels, which have reverted to green leaves.

This is an excellent illustration of the fact that the carpels are modified leaves, and should not be passed over by the teacher. The explanation of the two carpels in the Double Cherry has been given that the single carpel has split into two parts. This does not commend itself to the mind, because each carpel has a midrib of its own and is pinnately veined. It would seem more probable that while in the Double Cherry two carpels have been developed, in the single flower only one is present.

There is an early blossoming Spiræa (*S. thunbergii*), which is very commonly planted here. The corolla and stamens are similar to those of the other flowers we have studied. The ovary is free, as in the Cherry, but the carpels are separate and contain several or many seeds. This kind of ovary is a follicle, and distinguishes the tribe *Spireæ* among the other tribes of the Rose family.

We have no example of the third tribe, *Rubeæ*, as yet in bloom, for the Blackberry and Raspberry cannot be found till the middle of May. In this tribe there are many carpels,

containing each two ovules. The carpels are heaped on a conical receptacle, and become fleshy in fruit.

We have already studied the Strawberry, representing the Potentilla tribe. The carpels are also heaped on an enlarged receptacle, but they are akenes and remain dry in fruit.

We have no representative of the sixth tribe, the Poterium tribe, until July.

In the Rose tribe (*Roseæ*) the top of the stem has grown up into a hollow, urn-shaped receptacle, bearing the akenes on its sides (Fig. 20). The petals and stamens are inserted on the throat of this tube, and the styles protrude from the centre. The receptacle becomes fleshy and bright-colored in fruit.

Lastly, the Pear tribe (*Pomeæ*), seems, at first sight, to be very different from the others, in that it has a five-celled ovary, but this is really composed of five separate, simple carpels consolidated with the receptacle and the calyx into a single body.

All the flowers we have examined in this chapter are regular and complete; the stamens

are numerous, distinct, and on the calyx, and the carpels are simple, being combined in one tribe only The leaves are alternate, with stipules These characters belong to the whole family. The abundance of examples of the Rose family at the same season gives an unusual opportunity for exercise in classification.

Many of the members of the Rose [illegible] for instance, the Potentilla, bear a strong like-ness to the *Ranunculaceæ*, in their m[illegible] mens, innate anthers, and many separate [illegible] in a head; but the families may alwa[illegible] tinguished by the corolla and stamen[illegible] Crowfoot family being inserted b[illegible] ovary (hypogynous), while in the [illegible] family the corolla and stamens are on th[illegible] of the calyx (perigynous)

The Saxifrage family is very ne[illegible] the Rose family We shall find on the sc[illegible] that the families are distinguished by the Rose having alternate leaves with [illegible] opposite, as well as alternate [illegible] stipules This distinction, like most of our characters, is liable to exceptions.

THE RECEPTACLE.

An excellent lesson on the receptacle could be given in reviewing these flowers, or brought out by dwelling especially on this part of the blossom in each description.

The Cherry and Spiræa have flat receptacles. The Rose looks, at first sight, as if it had a calyx united with the ovaries, exactly as we find it in the Apple. But, making a vertical section of a Rose-hip (Fig. 20), we find that the ovaries are set on the sides of the tube, and that the inside of this tube, at least, must therefore be a part of the receptacle. The receptacle, as we know, is the part of the stem that holds the organs of the flower, and in the Rose it has grown up into a hollow disk, bearing the carpels on the inside.

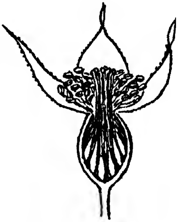

FIG 20 —Rose hip

Compare this hollow receptacle with that of the Raspberry or Blackberry. We can remember, if it is impossible to obtain specimens at the moment, how the red or black grains in these

fruits are heaped on the receptacle, from which the fruit of the Raspberry separates itself when ripe, while the blackberry is eaten, receptacle and all.

Compare the strawberry with these fruits, and let the scholars discover for themselves, if possible, what it is that ripens. The fruit now comes so early to our markets that specimens can generally be obtained. The carpels are heaped on a prolonged receptacle, as in the raspberry, but the carpels themselves do not ripen. They remain hard and dry, and it is the receptacle which ripens into the juicy fruit, holding the carpels on the outside as seed-like bodies. The lateral styles can still be seen, even when the fruit is quite ripe.

The last group, the Apple, Pear, and Quince, have fruit where the calyx, receptacle, and carpels are all consolidated into a single juicy fruit. We will describe this in the following lesson.

The Fruit.

The Rose family supplies so large a part of our common fruits that it seems desirable to introduce the subject here.

Early in May apples are still in the market, southern strawberries can be obtained, some of the summer berries can be studied in a green state, while oranges, bananas, and nuts can be procured at any time.

The fruit is the ripened ovary. In ordinary use, the term includes whatever other parts of the flower may adhere to and ripen with the ovary.

We may divide fruits into those resulting from a single flower, and those resulting from the ripening of two or more flowers. Both these classes may be divided, according to their consistency, into *dry* fruits and *fleshy* fruits. Let the pupils make these headings in their notebooks and place the fruits studied under the right headings.

We must remember that all such classifications are artificial and simply for purposes of convenience. They help pupils to remember the terms applied to different forms, and to recognize relationships.

We divide dry fruits into those which open to discharge their seeds (*dehiscent*), and those which remain closed (*indehiscent*). The former are

called pods. Fleshy fruits are generally indehiscent.

We may divide pods again into two classes, those resulting from a single carpel (*simple*),[1] and those resulting from several carpels united (*compound*).

The Spiræa, belonging to the Rose family, has a simple pod; that is, consisting of a single carpel. Our native Spiræas are all summer flowers, but we have several early blossoming kinds in our gardens. This pod splits only on one side. We have had a similar pod in the Caltha. This kind of pod is a *follicle*.

The most familiar example of a pod is a Pea pod. This splits on both edges, as all of us know who have shelled peas. A pod of one carpel which splits on both edges is called a *legume*, and from this term the whole Pulse family takes its name (*Leguminosæ*).

We have had many examples of pods result-

The word *simple* is applied in our text-book to fruits resulting from a single pistil. But we use the term *pistil* to include the whole seed-bearing portion of the flower, and our unit is the carpel, or single seed-leaf. We must therefore use the term *simple fruit* to apply only to the ripened single carpel.

ing from a compound pistil. They are called *capsules*, and the pods of the Tulip, the Blood-Root, the Violet, and many others are examples.

Indehiscent fruits have usually only one seed, for it would be useless for them to have many seeds, which would not be dispersed

An akene is a small indehiscent fruit with a single seed. We have had plenty of examples in the members of the Crowfoot and the Rose families. They are very often mistaken for seeds. An akene like that of the Maple and Ash, with wings, is called a key-fruit, or *samara.*

A chestnut is a good example of a *nut.* It has a hard shell, instead of a thin outer coat, and has several cells with one or two ovules in each cell. Generally only one of these ovules ripens into a seed, but every girl knows that there are sometimes two kernels in a nut, which she uses for a philopœna. In the process of ripening the wall of the ovary has become thick and hard, and the ovule has ripened into a fleshy, edible seed. The food was put there for the seedlings, however, not for the use of animals, which is the reason that it needs a good, strong, indehis-

cent shell to protect it. Many nuts have an involucre for a further covering, which is often prickly, as in the chestnut.[1]

Let us now examine some fleshy fruits. It is an excellent plan to study cherries in various stages of ripening, and to watch the formation of the stone. The inner wall of the ovary becomes gradually hard and stony, while the outer becomes fleshy and pulpy. The seed is therefore within the stone. Peaches and plums are similar to the cherry. All these fruits are formed of the ripened ovary, without any other part of the flower. They are called *stone-fruits*, or *drupes*.

A *berry* differs from a drupe in having the wall of the ovary turn fleshy all through, instead of the inner wall becoming hard. A grape is a true berry; so is a tomato. An orange is a berry with a separable rind, which has received a special name (*Hesperidium*), from the gardens of the Hesperides, where the wonderful golden apples grew. It is interesting to trace where the pulp comes from in these fruits. In the grape the pulp is developed from the wall of

[1] Reader in Botany. IX.

the ovary; in the tomato, from this wall and from the placentæ also; in the orange, principally from the hairs which line the ovary.

In all these the ovary alone ripens, but bananas, currants, blueberries, and cranberries are berries with an adherent calyx. The banana skin, which we split and tear away, is the calyx united to the outer wall of the ovary, and the three carpels are plainly distinguishable. It always amuses a class to show them that oranges, tomatoes, and bananas are technically berries, while huckleberries, raspberries, and blackberries are not. The botanical definition of a berry is a fruit where the wall of the ovary is fleshy throughout. This definition does not apply to the three fruits last mentioned, for each carpel has a little stone, and they are therefore a collection of drupes, or stone-fruits. Each of these grains is called a *drupelet.*

A third division of fleshy fruits are classified under the name of *pome.* These are fleshy fruits where both the calyx and the receptacle form a part of the fruit, as in the apple, pear, and quince. In the apple, both calyx and receptacle

have become fleshy (Fig. 18, 6). The walls of the carpels are hard and papery. They are the little tough bits that are apt to get between your teeth when you are eating an apple. The ten dots to be seen in the cross section of the apple are the ends of the fibro-vascular bundles belonging to the calyx and corolla. The quince is like the apple, except that the receptacle has not become fleshy, and the centre of the fruit is therefore hollow.

The raspberry and blackberry are *aggregate* fruits; that is, they are formed of many separate carpels, belonging to a single flower, that become consolidated in fruit. We call the dry fruit of Buttercup a head of akenes; a blackberry is a head of drupelets. In the raspberry, the receptacle is dry and the fruit separates from it; in the blackberry, the receptacle also ripens and becomes a part of the fruit.

When the principal part of the fruit belongs to something outside of the flower, the fruit is *accessory*, and of this we have an excellent example in the strawberry, where the receptacle is the edible part. This is a good example also of

the difference between the two definitions of fruit, — the restricted one, where the fruit is the ripened ovary, and the popular one, where it consists also of whatever parts may ripen with the ovary. In the first sense the fruit of the Strawberry would be described as a collection of akenes; in the second, as an accessory fruit.

Multiple or *collective* fruits are those which result from the ripening of two or more flowers into a single fruit. The fig is a good example. It is like a Rose-hip, except that the hollow flower-stalk contains many separate flowers, instead of carpels belonging to one flower. The little, seed-like bodies in the fig are the ovaries of as many separate flowers, contained in a hollow flower-stalk, which has grown pulpy and soft. The pineapple is a cluster of flowers where all the parts (the bracts, stem, and calyx belonging to each flower) ripen, become juicy, and unite into one fleshy mass. The axis of the stem grows on beyond the pineapple into a leafy branch. The Pineapple plant is always propagated by cuttings, the flowers being sterile.

The cone has always been described as a mul-

tiple fruit. But, if the view taken by Goebel that the whole cluster is a single flower be correct, we cannot place it in this division.

The mulberry is formed from a cluster of flowers, which ripen into a single mass and become a multiple fruit.

The partridge-berry is an example of a very simple kind of multiple fruit, where the two ovaries are united into one berry-like fruit.

After this lesson full descriptions of the fruit of the plants examined should always be required, whenever it can be obtained. See the descriptions of the members of the Rose family in the Appendix.

Gray's Lessons, 345–379.

CLASSIFICATION OF FRUITS.

FRUITS RESULTING FROM A SINGLE FLOWER.

- Dry
  - Dehiscent
    - Pod
      - Simple (of one carpel)
        - Follicle....Caltha
        - Legume...Pea
      - Compound (of two or more carpels)
        - Capsule...Violet
  - Indehiscent ....
    - Akene.....Buttercup
    - Nut.......Chestnut
    - Aggregate fruit.....Potentilla
- Fleshy..............................
  - Berry .....Grape
  - Drupe.....Peach
  - Pome... ..Apple
  - Aggregate fruit.....Raspberry
  - Accessory fruit.... Strawberry

FRUITS RESULTING FROM TWO OR MORE FLOWERS.

- Multiple or Collective Fruits..... .....
  - Fig
  - Pineapple
  - Mulberry
  - Partridge-Berry

VIII.

LATER SPRING FLOWERS.

BUTTERCUP (*Ranunculus bulbosus*).[1]

WE return to the Crowfoot family (*Ranunculaceæ*), which contains so many of our spring flowers. The Buttercup strongly resembles the Hepatica and Anemone, but the general appearance of a flower is not a very safe way to judge of relationships, for a beginner, at least, for mere form goes a very little way in classifying a plant. When the pupils have made their descriptions and learned the adnation of the flower, and the structure of the stamens and pistil, they can turn to their previous descriptions of other flowers of the Crowfoot family, and compare the Buttercup with them.

The root of this particular plant that we are now examining has a bulb, but we shall see, if

[1] Appendix, p. 324.

we gather other kinds of Buttercups, that this is not a character of the genus. It is, in fact, peculiar to the species, and we know at once that we have *Ranunculus bulbosus*, for from the presence of the bulb the plant takes its specific name (Fig. 21, 1, 2).

The leaves are radical, enclosing the bulb with the dilated bases of the petioles. They are palmately compound, with three divisions, cut and incised.

The Buttercup is a regular flower. It is also complete, differing in this particular from any of its family that we have before studied. It has a calyx of five sepals, a corolla of five petals, many distinct stamens with innate anthers (Fig. 21, 4), and an apocarpous pistil of many carpels in a head. All the parts are distinct and free. This will make us place it in the Crowfoot family. There are a few other families in our Manual, which have the parts all free and distinct, but they contain trees and shrubs, except the Barberry family (*Berberidaceæ*), which may be distinguished by having as many stamens as the petals, and opposite to them.

Müller says that the little scale at the base of each petal of the Buttercup secretes nectar. I have not been able to see or to taste it, and it seems to me that the flowers are visited by insects rarely, and then chiefly for the pollen, which is very abundant. The outer anthers dehisce first, each stamen bending outwards when discharging.

The stigmas develop more slowly and are covered and protected from contact in the young flowers by the inner anthers. Later, when the innermost anthers are dehiscing, the stigmas are fully developed. Therefore, an insect alighting first in the centre of an older flower would effect cross-fertilization, while if it alighted on the outside of the flower and touched first the anthers and then the stigma it might effect either cross-fertilization or self-fertilization. Müller states that the modes of alighting are about equally common. If no insects visit the flower, it may be fertilized by the outermost stigmas touching the innermost anthers.[1]

The fruit of the Buttercup is a head of akenes. Each carpel has a sessile stigma, slightly beaked (Fig. 21, 5, 6, 7).

[1] The Fertilization of Flowers, pp. 74–77.

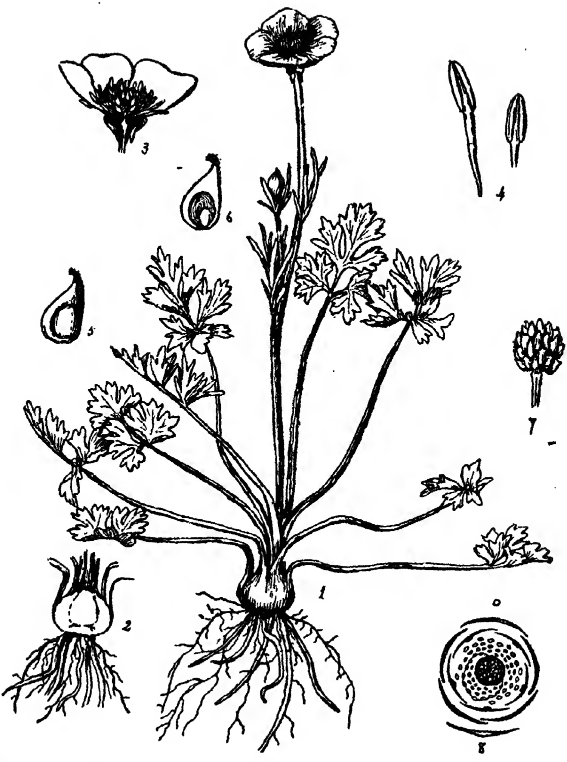

FIG. 21.— Buttercup. 1. Whole plant. 2. Section of bulb. 3. Section of flower. 4. Stamens. 5. Carpel. 6. Section of carpel. 7. Head of carpels in fruit. 8. Diagram (Eichler).

WILD COLUMBINE (*Aquilegia Canadensis*).[1]

The Columbine is one of our most attractive wild flowers. Its nodding blossoms with the upturned spurs are pretty to look at and pleasant to study. The name, Aquilegia, has been thought to refer to the resemblance of the spurs to eagle's talons, but the derivation is uncertain. So also is the meaning of the name Columbine (Latin, *columba*, a dove). The prettiest explanation is that of Prior, who says that the resemblance of the ends of the spurs to the heads of pigeons around a dish, a device we often see in Roman mosaics, gave the flower its name.[2]

We suppose always in these outlines of lessons that the pupil makes as full a description of each flower as his knowledge will permit. We mention here only the characters that seem to call for special mention. A full description will always be found in the Appendix.

The Columbine has a short tap-root (Fig. 22, 1). The leaves are both *radical*, springing

[1] Appendix, p. 325.

[2] Popular Names of British Plants, ed. 2, p. 51.

apparently from the root, and *cauline*, on the stem above ground. These words are very unfortunately chosen for our present state of knowledge, because all leaves are cauline and belong to the stem, but no one has yet suggested any better terms, and these will be found in all our text-books and manuals. The leaves are alike, except that the radical leaves are twice compound, while the cauline leaves are once compound, the divisions deeply parted, or even less divided. The bracts are like the leaves, but less cut.

The most noticeable thing about the flower is the shape of its petals. They are hollow spurs, and the pupil will soon discover that they contain nectar, and will notice, if his attention is called to it, that the stamens are bent downwards before the anthers are mature, but as they become ready to discharge their pollen they rise and stand erect around the styles below the stigmas. The inner stamens are longer than the outer, and dehisce first, reversing the order of the Buttercup. The change in the position of the anthers is also the reverse of that of the Buttercup, where the stamens bend down while

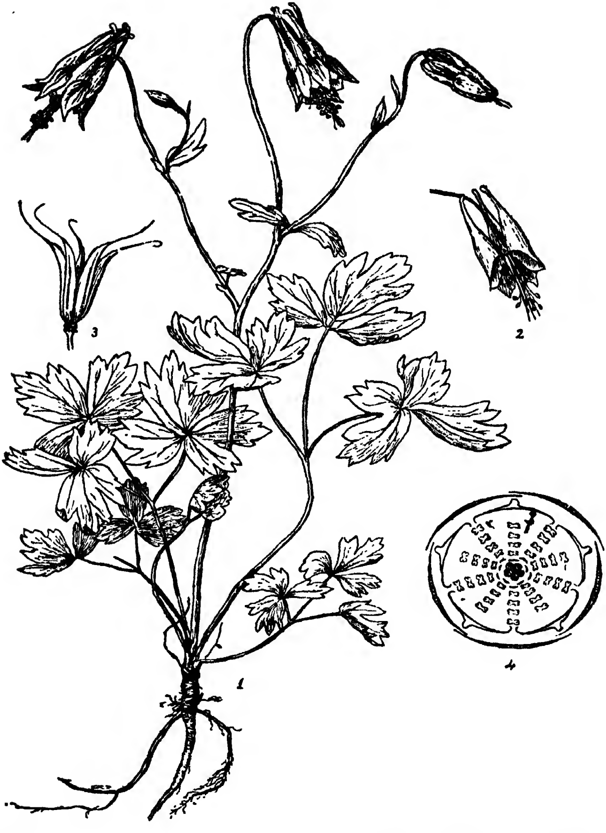

Fig. 22. — Columbine. 1. Whole plant. 2. Section of flower. 3. Fruit. 4. Diagram.

discharging. The explanation of the difference would undoubtedly be found by watching the insects at work. Müller and Sprengel[1] describe carefully the fertilization of *Aquilegia vulgaris*, the common Garden Columbine, but this plant has hooked spurs. Dr. Goodale says, "It is not yet quite clear in what way the visiting insects aid in the fertilization, but there is good reason for believing that they carry pollen from younger flowers to the stigmas of older blossoms."[2] It is rather strange that, with so much investigation going on, the fertilization of such a common flower as the Columbine should not be understood, but the fact is that most investigators concern themselves principally with histological matters, and there is an endless field of inquiry open to any one who knows how to use his eyes. This being the case, what study could be made more interesting and stimulating to the boys and girls of a country academy than the study of the flora of their neighborhood? A

[1] The Fertilization of Flowers, p. 81. Das Entdeckte Geheimniss der Natur, p. 279. See also American Naturalist, XIV, pp. 731–737. The Fertilization of Aquilegia vulgaris. W. Trelease.

[2] Wild Flowers of America, p. 4.

good teacher might direct and collate such observations so as to add to our knowledge of the life-habits of our plants.

The inner stamens of the Columbine are sterile and membranaceous. I can find no suggestion as to their use in the economy of the flower. The anthers are innate, as in all the members of the family. The Rose family has innate anthers also.

The Columbine has a compound, apocarpous pistil, of five or more carpels. The resemblance of the open carpel to a leaf, after the seeds have discharged, is very striking. It is used as an illustration of the theory of the flower (chapter xii). The fruit will not be ripe when the flower is studied.

The seeds are small, black, and shining. The carpels change from a nodding position in the flower and become erect in fruit. They split towards the top, and when swayed by the wind the seeds are thrown out to a little distance.

The pupils should have no difficulty in placing the Columbine in the *Ranunculaceæ*. The flower shows that form is not of very much significance

in classification, for it bears very little resemblance to the Buttercup and Anemone.

Pale Corydalis (*Corydalis glauca*).[1]

This pretty little flower lasts sparingly all through the summer, and may even be found late in the fall. It has a delicate look from the smooth, pale green (*glaucous*) leaves and stem. It takes both its specific name, *glauca*, and its common name, the Pale Corydalis, from this characteristic. The leaves are compound and very much dissected. The root is biennial, a thick tap-root.

The flowers are nodding, rose-colored, tinged with yellow at the tips of the petals. They are in long, loose terminal clusters, the oldest flowers at the bottom (*raceme*).

There are two very small sepals, and four petals, the upper petal with a blunt spur. The lower petal is boat-shaped, and both of these petals have yellow, reflexed tips. The lateral petals are spoon-shaped, with thick crested tips which unite to make a hood over the anthers

[1] Appendix, p. 326.

and stigma. An insect in search of nectar alights on this hood, which is in the centre of the flower, and thrusts its proboscis between the hood and the upper petal. The weight of his body presses the petals downwards, but the style, being stiff, does not bend, and strikes the insect's body.

The stamens mature before the style (*proterandrous*), and this insures cross-fertilization. When the pollen is ripe it is discharged with great suddenness when the stamens are disturbed.

The pods are long, linear, erect, and one-celled, with two placentæ on the walls. The seeds have a little spongy crest at the base, called a *caruncle*, or, more properly, perhaps, *strophiole*. They are shining and wrinkled.

The Corydalis belongs among the polypetalous families with hypogynous corolla and stamens, the first group on the schedule. The dissected leaves, watery juice, four irregular petals, six stamens in two sets, and one-celled pod with two parietal placentæ, mark it as belonging to the Fumitory family (*Fumariaceæ*).

The Dutchman's Breeches (*Dicentra Canaden-*

sis) is another spring plant belonging to this family. This flower has a two-spurred corolla, making a heart-shaped blossom. The common Garden Dicentra, known as Dielytra, is also a very interesting flower.

WILD SARSAPARILLA (*Aralia nudicaulis*).[1]

This plant blossoms in May. It has long, thick, aromatic rootstocks, which are used as a substitute for Sarsaparilla, and give the plant its common name.

The single leaf consists of three primary divisions, each with five, pinnately-arranged, lance-ovate leaflets. It arises from near the ground, and in its axil is a scape bearing three umbels of flowers with a few tiny bracts at the base of each umbel.

The flowers are complete, but the calyx is minute and deciduous, so that it is very easy to mistake the corolla for a single perianth circle. The petals are five, small, greenish, and on top of the ovary. The stamens are also epigynous. The ovary is five-celled with five styles.

[1] Appendix, p. 328.

The fruit of the Wild Sarsaparilla is a dark blue, berry-like drupe.

The Aralia is the only genus we have belonging to *Araliaceæ,* the Ginseng family. This family belongs in the last division on our schedule of the polypetalous plants, and is distinguished by having the flowers in umbels, the parts all in fives, several styles, and the fruit a fleshy drupe. We shall see that it resembles greatly a large and important family which we shall soon study, the *Umbelliferæ,* but is distinguished from that family by the five styles and the fleshy fruit.

Another very nearly related family is the Cornel family (*Cornaceæ*), and of this we have a beautiful specimen at this season, the Flowering Dogwood (*Cornus florida*).

This is a shrub very abundant in the woods of the Middle and Southern States, though not so common in New England.

The showy parts of this plant are the large white bracts which surround the clusters of small regular flowers and play the part of attractive organs to insects.

This family may be distinguished in the epigynous group by the single style, the single ovule hanging from the top of each cell (*pendulous*), and the one to two-seeded drupe. The species are all shrubs and trees, with the exception of the dwarf Cornel, or Bunchberry, and the stem of this low plant is woody.

In this connection a lesson on the Honeysuckle family (*Caprifoliaceæ*) will be appropriate. The Hobble-Bush (*Viburnum lantanoides*) and some of the other Viburnums flower at about this time, as well as some of the garden Honeysuckles. The evident relationship between the Viburnum and the Cornus, for instance, will disabuse the minds of the pupils of the idea that there is a great gulf fixed between the polypetalous and gamopetalous orders. A plant belonging to the Honeysuckle family, the Diervilla, is described in the first chaptĕr on Early Summer Flowers.

FRINGED POLYGALA (*Polygala Paucifolia*).[1]

Our little fringed Polygala is a difficult plant to analyze, it is so extremely irregular. Begin-

[1] Appendix, p. 329.

ning at the outside on the top of the flower, we find a boat-shaped sepal, beneath which the ovary is found, jutting out between the lateral petals. On the same plane as this upper sepal we find two broad and brilliantly colored wings, which are the lateral sepals, and below two small lanceolate, greenish perianth leaves, which are the lower sepals. These five very diverse sepals make the calyx.

Within, we find two lateral petals united in a tube with a lower petal, which is crested at the tip. The border of the tube is three-lobed. The rudiments of the two upper petals are found as a double gland at the base of the upper sepal.

There are six stamens, united in two sets of three, adnate to the lateral petals.

The ovary is flattened and two-celled, with a single ovule in each cell. The fruit is a flattened pod, rounded and notched at the apex, and two-seeded.

The seed has a lobe called a *caruncle*.

The plant is low, with short, flowering stems from long, underground branches, which bear also tiny subterranean flowers (cleistogamous flowers).

The latter look like small buds, and contain rudimentary petals and few stamens, containing pollen-grains, which send out the pollen-tubes and fertilize the ovules without leaving the anther. These flowers develop good pods and seeds.

The lower leaves of the flowering stems are scale-like ; the upper leaves are crowded near the summit. The flowers terminate the stem, and are rather showy, rose-purple, with large wings and a keeled, fringe-crested lower petal.

The style is longer than the stamens and curved, following the line of the keel. The anthers are one-celled and open by a chink in the top.

The genus Polygala is our only representative of the family *Polygalaceæ*, which will be found among the flowers with hypogynous corolla, and may be recognized by its very irregular flowers with one-celled anthers opening at the top, and the two-celled, two-seeded pod.

BARBERRY (*Berberis vulgaris*).[1]

One of our favorite adopted citizens of the wild garden is the Barberry, with its graceful,

[1] Appendix, p. 330.

recurved branches, bearing yellow drooping flower-clusters, or brilliant scarlet berries.

The shrub is a native of Europe, but has become well established in New England. The leaves are alternate, in clusters in the axils of branched spines, which are modified leaves of the preceding season. The petiole of each leaf is jointed. This joint shows its relationship to the pinnate or three-parted leaf possessed by other members of the family. It is a compound leaf reduced to a single member.

The flowers are small and regular, in drooping, many-flowered racemes. They have six sepals, six petals, six stamens, and a simple pistil. At the base of each petal are two fleshy, orange-colored nectar-glands, which make the flower more conspicuous.

The stamens are opposite the petals, and the anthers open by uplifted valves, hinged at the top. These characters belong to the Barberry family (*Berberidaceæ*).

The stamens are sensitive. A touch at the base of the filament will cause the stamen to fly up towards the centre of the flower, exploding

the pollen. Sprengel supposed that this movement caused self-fertilization, by the pollen being thrown on the stigma. Müller, however, shows that it is generally thrown against the visiting insect, and that cross-fertilization is the more usual result.[1]

The berries of the Barberry are very acid and are little eaten by birds. There are few seeds. The seeds have a hard covering.

The family to which the Barberry belongs takes its name from that genus. It will be found near the beginning of our schedule, and is distinguished by opposite stamens, anthers opening by uplifted valves, and a simple pistil. Certain exceptions may be noted. The May-Apple (*Podophyllum*) has anthers which do not open by uplifted valves.

JACK-IN-THE-PULPIT; INDIAN TURNIP (*Arisæma triphyllum*).[2]

We come now to a flower representing an entirely different class from those which we have lately studied.

[1] The Fertilization of Flowers, p. 92. [2] Appendix, p. 331.

If we pick a number of specimens of our common Indian Turnip, and selecting one, open the enfolding leaf, we shall find within a smooth, pale green, club-shaped spike, with a group of organs about its base. These organs differ in different plants, and we had better begin by separating our specimens into two heaps, placing those which are alike together, and distributing one of each kind to each pupil.

In one of the heaps we shall find flowers in which the group of organs consist plainly of stamens. We recognize them by their nearly sessile anthers, opening by pores in the top. These anthers, looked at through a lens, are seen to be either two-celled or four-celled, and are arranged in groups of two or three (Fig. 23, 2).

The other set of specimens will be found to resemble the first, except that the organs are one-celled ovaries, tipped with a depressed stigma (Fig. 23, 3, 4). We regard each group of stamens or single ovary as belonging to a separate flower, because we have very nearly related plants, such as the Skunk-Cabbage (*Symplocarpus fœtida*), where there are floral envelopes around

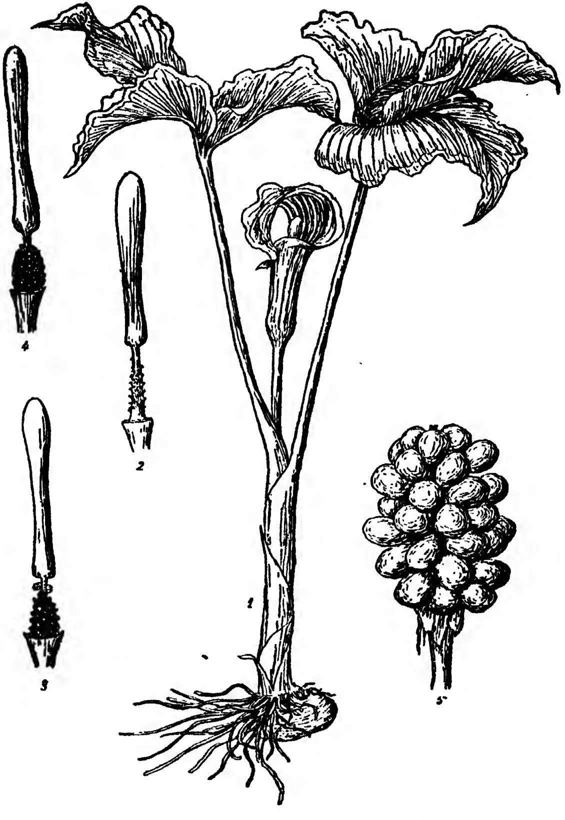

FIG. 23.—Jack-in-the-Pulpit. 1. Whole plant. 2. Spike with staminate flowers only. 3. Spike with both pistillate and staminate flowers. 4. Spike with pistillate flowers only. 5. Fruit.

each corresponding group of organs. In the Arisæma there is no trace of calyx or corolla.

The flower-stalk upon which these very simple flowers are inserted is prolonged into a club-shaped appendage, and is called a *spadix*. In the Skunk-Cabbage the flowers cover the whole of the spadix, but in our Arisæma we describe their inflorescence by saying, "flowers clustered on the base of a naked spadix."

The hooded covering is a bract, since it surrounds a cluster of flowers, and a bract of this kind surrounding a spadix is called a *spathe*.

We might call the flowers of Indian Turnip, "flowers reduced to their simplest terms," for one kind consists simply of a group of stamens, and the other of a one-celled ovary, crowned with a sessile stigma.

Sometimes we find spikes with both stamens and pistils (*andrŏgynous*). When this is the case the staminate flowers are above and the pistillate flowers below. Such a flower may be seen in Fig. 23, 3. This plant is monœcious, having both stamens and pistils; the other plants are diœcious. This is an instructive example

of the way in which a plant may become diœcious, by the gradual abortion of one kind of flowers. In the Skunk-Cabbage the flowers are *perfect*, with both stamens and pistils in the same flower. In describing such flowers as the Arisæma we must be careful to avoid confusion in the use of the word *flower*. In ordinary language we apply it to the whole cluster, but, as we have seen, it is strictly used to mean each group of essential organs, with or without floral envelopes.

The underground part of the plant resembles the Crocus, the nourishment being stored in the lower part of the stem. This corm is pungent, and when eaten bites the tongue severely, but not immediately. The acrid qualities are destroyed by long boiling, and the plant is sometimes used for food, whence the name "Indian Turnip."

The flower is probably fertilized by flies, but I have not been able to make any observations upon it nor to find any in print. It would be a good subject for investigation by the pupils.

The fruit is a cluster of red berries, contain-

ing from one to four seeds. As in all juicy berries adapted to be eaten, the seed-coats are very hard and indigestible. The seed is round, with a large scar at the base.

A beginner would be likely to place this plant among the dicotyledons, because it has net-veined leaves, but it is an exception to the general rule. In the key of the Manual it is placed among the plants which would be mistaken for dicotyledons on account of their foliage. If we examine the stem we shall find it of the monocotyledonous type.

In the monocotyledons we place it at once in the *spadiceous* division, because it has its flowers upon a spadix. The most important family in this division is the Arum family (*Araceæ*), to which our plant belongs. It is distinguished by having the flowers crowded on a spadix, usually surrounded by a spathe, and the fruit a berry. Other members of this family are the Water Arum (*Calla palustris*), the Skunk-Cabbage, and among house-plants, the beautiful Calla Lily. In the Calla the lowest flowers on the spike are perfect, while the upper flowers

are staminate only. The bract is so very conspicuous that it is always spoken of as constituting the flower. In the Indian Turnip the bracts vary in different flowers. Some of them are green, striped with darker green lines, while others are striped with purple. Dr. Torrey, in the Flora of New York, states that the green ones are staminate, while the purple ones have pistillate flowers only. In the allied English plant, Lords and Ladies (*Arum maculătum*), the purple striped ones are known as "Lords," the green ones as "Ladies."

Stemless Lady's Slipper; Moccason-Flower (*Cypripedium acaule*).[1]

We have had examples of several monocotyledonous families with colored perianth, the Lily, the Amaryllis, and the Iris families. There is another family in this group, with one or two stamens only, and inferior ovary, which we have not studied. This is the Orchis family (*Orchidaceæ*), which contains a great many rare and wonderful plants, to be seen in greenhouses.

[1] Appendix, p. 332.

Some of them are *epiphytes*, or air-plants, and store up their food in swellings of the lower internodes. Almost all of them are of peculiar shapes, and adapted in the most wonderful way for cross-fertilization.

Most of our common orchids are summer flowers, but there is a beautiful member of the family to be found in May, which is not uncommon, the Lady's Slipper (*Cypripedium*). The stemless Lady's Slipper (*C. acaule*) is the most widely distributed species of this genus, in New England, at least.

Making a vertical section of the flower (Fig. 24, 2), we see all the parts exposed to view. There is a green bract at the base of the ovary, apparently on the upper side of the flower.[1]

Then comes the calyx (Fig. 24, 2, *c*), which has two lobes. The lower lobe, however, is larger and composed of two lobes united, as the flower

[1] The bract is really below the flower, and the lip is really the upper petal. A twist in the ovary has caused the lip to appear as if it were the lower petal of the flower. Darwin disregards this in his diagram (Fig. 25), but the true arrangement is given in the diagram copied from Eichler (Fig. 24, 4).

is on the plan of three. This can be traced in the veining.

The corolla has three petals. The lateral ones droop, and are long, pointed, and oblique (Fig. 24, 2, *d*). They look so much like the sepals that any pupil would call these four perianth leaves the calyx.

The third petal is the drooping lip (Fig. 24, 2, *e*). This is a large pouch, with the edges turned inwards, so as to make a sort of pocket, and thickly covered with sticky hairs.

We see the anthers of two perfect stamens (Fig. 24, 2, 3, *h*), one on each side of the style, and united with it to form the column. These anthers are two-celled, and covered with a sticky varnish. We cannot touch them with a pencil, without carrying away some of the pollen. But what is the petal-like body above the style, covering it and the anthers? It is united to the filaments of the fertile anthers, and forms a part of what is known in this family as the *column*. It is a sterile stamen (Fig. 24, 2, 3, *f*).

All these three stamens occupy the upper part of the flower, so that they cannot be

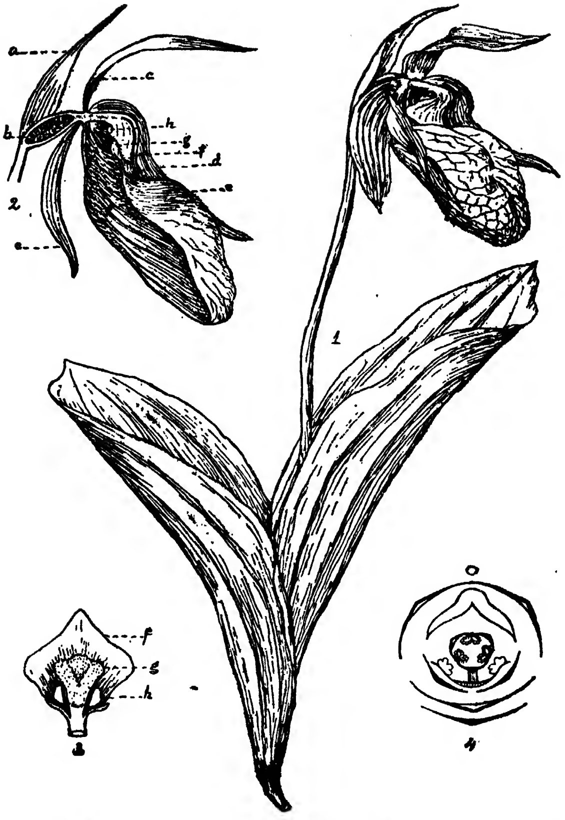

Fig. 24. — Lady's Slipper. 1. Flower-stalk and leaves. 2. Section of flower: *a*, bract; *b*, ovary; *c*, sepals; *d*, lateral petal; *e*, lower petal (lip); *f*, upper stamen; *g*, stigma; *h*, lateral stamen. 3. Upper stamen, with lower fertile stamens and stigma. 4. Diagram.

regarded as a single circle of stamens, alternating with the corolla, as is generally the case when the number of stamens and petals is the same. There is a stamen opposite each of the three upper divisions of the perianth. It has been shown in a masterly way by Darwin, in his wonderful book, the Fertilization of Orchids,[1] that the rudiments of three other stamens exist opposite the three lower perianth divisions, and of these the two lateral ones help to make the spreading lip, while the lower stamen strengthens the column. Fig. 25 represents the plan of the Orchid family as given by Darwin. In this figure, *A*, 1, 2, 3 are the outer whorl of stamens opposite the sepals. *A*, 1 is the sterile stamen in the Lady's Slipper. *A*, 2 and 3 are combined with the lip or *labellum*; *a*, 1, 2, 3 represent the inner whorl of stamens opposite the corolla. Of these *a* 1 and 2 are fertile in Cypripedium, and *a* 3, according to Darwin, cannot always be traced, but when it is present forms the front of the column.

[1] On the various contrivances by which Orchids are fertilized by Insects, by Charles Darwin. D. Appleton, N. Y., 1877. Pages 234–238.

The style is terminated by a moist and roughened stigma which shows plainly by its three lobes that it is composed of three carpels.

The ovary is one-celled, with three placentæ on the walls. There are innumerable seeds, so fine

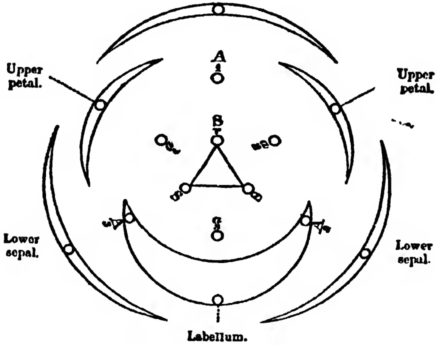

FIG. 25.—Cross section of an Orchid. (Darwin.)

and small that they resemble sawdust. When we consider the greediness of flower-gatherers, we ought to be grateful that a single flower is capable of producing so many descendants, as the flower is entirely dependent on its seed for reproduction.

We have thus fifteen organs. Three sepals, three petals, six stamens, in two circles, and three carpels, each circle alternating with the last; but the succession and arrangement are made exceedingly obscure by changes caused by the cohesion of the parts and the suppression of some of the organs. If we compare this diagram with that of the Tulip (Fig. 1), we shall see that the fundamental arrangement is the same, and botanists believe that the change has been brought about in the course of ages by successive modifications of a simple ancestral form.

The fertilization of this flower is very interesting. We will quote the account from Dr. Gray: —

"Unlike other Orchids, there are two stamens: the pollen is powdery, or between powdery and pulpy, and not very different from that of ordinary flowers. As it lies on the open anther in a broad patch, it somehow gets a film like a thin coat of sticky varnish. The stigma is large, flat, and somewhat trowel-shaped, the face turned forwards and downwards: it is supported on a stout style,

to which the anthers have grown fast, one on each side. This apparatus is placed just within the upper part of the sac or slipper (rather like a moccasin than a slipper), which gives the name to the flower. There are three openings into the slipper; a large round one in front, and the edges of this are turned in after the fashion of one sort of mouse-trap; two small ones far back, one on either side, directly under each anther. Flies and the like enter by the large front opening, and find a little nectar apparently bedewing the long hairs that grow from the bottom of the slipper, especially well back under the overhanging stigma. The mouse-trap arrangement renders it difficult for the fly to get out by the way it came in. As it pushes on under the stigma it sees light on either side beyond, and in escaping by one or other of these small openings it cannot fail to get a dab of pollen upon its head, as it brushes against the film with which the surface is varnished. Flying to the next blossom and entering as before, as the insect makes its way onward, it can hardly fail to rub the pollen-covered top of its head against the

large stigma which forms the roof of the passage."[1]

The Lady's Slipper is by no means a typical representative of the Orchis family. Darwin says: "An enormous amount of extinction must have swept away a multitude of immediate forms, and has left this single genus, now widely distributed, as a record of a former and more simple state of the great Orchidean order."[2]

If we can obtain an Orchis, or some nearly related genus, to compare with the Cypripedium, we shall give a fair idea of the family. *Orchis spectabilis* is to be found at the same season as the stemless Lady's Slipper, but it is not nearly so common a flower. Foreign Orchids that will answer quite as well, can be obtained at many greenhouses, but they are expensive. If no specimen can be procured, a little time at least should be spent in pointing out the more usual family characteristics.

[1] How Plants Behave. By Asa Gray. Ivison, Blakeman, Taylor & Co., 1872. Page 31.

[2] Fertilization of Orchids, p. 226.

All Orchids, with the exception of the genus Cypripedium, have a single fertile anther. This occupies the position of the sterile stamen in Lady's Slipper (Fig. 25, *A*, 1). The other five stamens exist only as rudiments. This fertile stamen has two cells which are widely separated, and might easily be mistaken for two separate stamens. Each cell contains a pollen-mass (*pollinium*) attached to a stalk (*caudicle*) with a sticky disk at the end. These sticky disks are so placed that an insect entering to get nectar will strike them and draw them out of these resting-places. This may be easily seen by experimenting with a pencil, or other sharp-pointed instrument.

Below is the stigma, which, in the case of the Orchis, consists of two lateral, sticky surfaces. The third lobe of the stigma is modified into a peculiar organ, known as the *rostellum*, which takes different shapes in different species, and is marked *r* in Fig. 25. The viscid disks before mentioned are enclosed in this rostellum, which makes a sort of lip that depresses at a touch, exposing the two sticky balls of matter.

If an insect, probing for nectar, comes in contact with one of these disks, the viscid matter adheres to its head, and in a few moments sets hard, like cement. The insect carries these pollen-masses on its head to another flower.

Here it is brought against the sticky stigma, which pulls off some of the pollen-grains, which are fastened together by elastic threads.

The manner in which this is accomplished has not, apparently, been fully studied in *Orchis spectabilis*. The account of the British species, *Orchis mascula*, will be found beautifully complete in Darwin's work, just cited. He describes the wonderful downward movement of the pollen-masses, by which they are brought into position to touch the stigma of the next flower visited.[1] Dr. Gray implies that the same action takes place in *Orchis spectabilis*, but in a few that I have examined the movement of the pollen-masses was in the wrong direction. This would be an excellent field for investigation in localities where such researches are possible.

Let us sum up the differences between Cypri-

[1] Reader in Botany, X, "Fertilization of Orchids."

pedium and other Orchids: it has two fertile anthers, belonging to the outer circle of stamens, instead of one belonging to the inner circle; the pollen is loose and powdery, instead of being united into masses, and no part of its stigma is developed into a separate organ (*rostellum*).

ÆSTIVATION.

The *æstivation* of a flower-bud is the manner in which the parts are arranged. We have already studied the vernation of a leaf-bud, which is the disposition of the leaves in the bud.[1] The same terms are employed for the flower. A slight review of the various modes that we have observed may be taken.

We represent the æstivation of a flower by means of diagrams. We can study the arrangement of the flower-leaves by making a cross section of the bud. This is better than removing the parts one by one, as we did in the Tulip, for it shows us the relation of the stamens and the pistil to the corolla. A diagram, as we have seen, is a ground plan of the flower,

[1] Outlines, Vol. I, p. 92.

and it should exhibit the arrangement of every part.

In the the calyx of the Fuchsia we have an example of *valvate* æstivation; the parts meet edge to edge, without overlapping. The staminate flowers of Begonia have a valvate perianth. The petals of our common Clematis have the edges turned inward (*induplicate*), and those of the Norway Maple turn outward (*reduplicate*). These are varieties of valvate æstivation.

Sometimes the parts do not touch each other in the bud at all, and then they are *open*, as in Shepherd's Purse.

The corolla of Fuchsia exhibits a mode where the petals overlap, each petal having one edge within and one edge without. This is *convolute*, and the House-Geranium has a similar æstivation

The commonest mode of arrangement is *imbricated*, with one or more of the petals wholly within, and one wholly without. We have had numerous examples of this.

The usual rule in the arrangement of the parts of a flower is that succeeding members arise in the intervals of former ones. The

circles of the flower usually alternate, as we saw in the Tulip. Normally, also, the carpels, or cells of the pistil, alternate with the inner row of stamens. The plan of the Tulip, therefore, is a typical one. There are a great many exceptions to this rule, caused by the abortion of members, or of whole circles of organs, and the consequent displacements of the other parts.[1] A very striking example of such changes is given in the study of the Lady's Slipper in this chapter.

Gray's Lessons, 276–280.

[1] There are cases where many botanists think that the parts are formed opposite former members, and are not changed by the union or suppression of members. The following passage is instructive in this connection. "It must be borne in mind that the normal alternation of the parts of the flower is only a fact of experience, which loses its validity as a general rule as soon as a number of opposing facts are known." — Goebel's Outlines, p. 419.

IX.

COMMON WEEDS.

SHEPHERD'S PURSE (*Capsella Bursa-pastoris*).[1]

THIS weed is very common, by fields and roadsides, so that it is easily obtained. The flowers are small, but most of the characters can be made out with a hand lens. We can almost always find pods and flowers on the same plant, and if the ovary is too small to see the structure, the pod will help us to understand what it must have been.

The plant has a tap-root, which is very tough and somewhat woody (Fig. 26, 1). The leaves are radical from a very short underground stem, and also alternate on the flowering stems. All the leaves are pinnatifid, either lobed, toothed, or cut; the stem-leaves are clasping, with auricles at the base.

The flowers are in terminal racemes (Fig. 26, 1)

[1] Appendix, p. 334.

which elongate greatly as the season goes on. They have four white petals, arranged in the form of a Greek cross, and six stamens in two rows, the outer row of two short stamens, and the inner row of four long ones. These characters distinguish the whole family, which takes its name, *Cruciferæ*, cross-bearing, from the shape of the corolla.

The pod is flattened and triangular, and has a thin membranaceous division stretched across from the two placentæ. In an old pod we can pull away one of the valves from the partition and leave the ovules on the placentæ, as in Fig. 26, 3. We can see the wall with both valves fallen off and the stalks of the ovules left in Fig. 26, 4. This is really a false partition, which grows out from the carpels and connects their margins. We have, therefore, a two-celled pod, with parietal placentation (Fig. 26, 4). This kind of pod is peculiar to the Cress family. It is technically termed *silicle* in the Shepherd's Purse; in the Mustard, where the pod is long and narrow, it is called a *silique*. The Garden Stock offers a good example of a silique, and is

FIG. 26. — Shepherd's Purse. 1. Whole plant. 2. Flower with two petals and two stamens removed. 3. Pod, one valve detached. 4. Portion of pod after the seeds have dropped off. 5. Diagram.

so large that it can be more easily studied. Perhaps, on this account, the teacher may prefer to use it as the flower for class study, instead of the Shepherd's Purse.

There is another kind of pod in the Cress family, a pod which separates across into one-seeded joints. This is called a *loment,* and the pod of the Radish is an example.

We can recognize the Cress family by the four petals, two short and four long (*tetradynamous*) stamens, and the two-celled pod, with the ovules on the walls.

Common Chickweed (*Stellaria media*).[1]

This little flower is familiar to every one. It is small and will require rather careful handling. The leaves are opposite and simple, the upper sessile, the lower on hairy petioles. Through a lens a single hairy line may be seen running all along the stem.

The arrangement of the flower is determinate. A flower always terminates the stem and from the axils of the nearest leaves spring branches

[1] Appendix, p. 335.

with a flower on the end of each branch. Then these branches may again branch, and so on. This, as we have seen in the Houstonia, is a *cyme*.

The flower is small. The pupil may think that it has ten petals, because they are so very deeply parted, but a little careful examination will show them that the divisions are joined at the base.

There are usually but three stamens, but the number varies from three to ten.

If the ovary is too small to examine satisfactorily, let the pupils look for pods. The oldest pods will be found at the lowest fork of the flowering part of the plant. This was the first flower developed, and terminated the stem. Very likely this pod has already split into six valves, and nothing is left in the middle but a tiny convex placenta, where the seeds were fastened. It looks like a green calyx, for the valves of the pod are like leaves. They show very plainly, what we have before stated, that the carpel is a modified leaf. We can split a pod that is not quite so old by pressing it, and see the seeds within, piled on a central placenta, not united to the

walls. This is called a *free central* placenta. It is characteristic of the Pink family. When we find a flower which is polypetalous and has a placenta of this kind we can probably place it among the Pinks; when it is gamopetalous it belongs to the Primrose family.

We may compare the pod of this Chickweed with that of the Mouse-Ear Chickweed (*Cerastium vulgatum*), which is also a very common weed. The pod of the latter opens by five teeth, but does not split to the base. We find the little golden seeds in some of the Chickweed pods. They are curved (*campylotropous*), so that the scar where the seed was attached to the placenta (*hilum*) is brought very near to the opening through which the ovule was fertilized (*micropyle*).

The nectar-glands are at the bases of the outer filaments. The stigmas expand while the stamens are dehiscing, and, as they are below the anthers, self-fertilization can easily take place.

According to Müller, "cross-fertilization and self-fertilization, in the event of insect visits,

are both equally likely; in the absence of insects the stigmas regularly fertilize themselves by coming in contact with the anthers. This self-fertilization is undoubtedly efficient, for *Stellaria media* produces abundant seed in winter when no insects are about, and in long-continued rainy weather."[1]

We have no difficulty in placing this plant in its proper family, the Pink family (*Caryophyllaceæ*). It is a dicotyledon, polypetalous, and the corolla and stamens are inserted under the ovary. It has the same number of sepals and petals, separate styles, and a free central placenta. The flower we have had that most nearly agrees with these characters is the Claytonia, but that had two sepals only, and belongs to the *Portulacaceæ*, which comes next to the Pinks in the Manual.

Ground-Ivy; Gill (*Nepeta Glechoma*).[2]

This is a common weed in fields and waste places. It is a good example of its family (*La-*

[1] The Fertilization of Flowers, p. 136.

[2] Appendix, p. 336.

biatæ), although there are other flowers which are larger and more easy to examine.

The stem is a very characteristic one. It is square, hairy, and jointed, with thick brushes of hairs at the joints. The leaves are opposite, without stipules, but with this brush of hairs connecting the bases.

The flowers are in cymose clusters in the axils, and their stalks are so short that the clusters are quite close to the stem.

The flowers are small, about half an inch long. The calyx is gamosepalous and free. The corolla is two-lipped (*bilabiate*), a form we have not met with before. We can trace the number five in it, however, for the upper lip is two-lobed and the lower lip three-lobed. In fact, the upper lip is formed of two united petals, and the lower lip of three. The stamens are four, in two lengths (*didynamous*), and the anthers are very peculiar. If we look at a flower in which the anthers have dehisced, we shall find them forming two little crosses (Fig. 27, 4, 6, 7). The cells of the anthers diverge, and as each pair is close together (*approximate*) a cross is formed.

Some of the plants of Ground-Ivy have smaller flowers, which are more highly fertile, but have sterile, club-shaped anthers.[1]

The ovary is different from any that we have studied. It has four deep lobes (Fig. 27, 8), which split apart when the fruit is ripe into four little separate *nutlets*. But we say that the ovary is syncarpous, for there is only one style, rising from the centre surrounded by the four lobes.

The flower is plainly adapted for cross-fertilization. At the base of the flower, just under the ovary, is a nectar-gland (Fig. 27, 8, *b*). This makes the ovary rather puzzling at first sight, for it looks as if there were five lobes. As

[1] Müller explains this abortion of the stamens by supposing that the plants varied and produced some less conspicuous flowers. As these less attractive flowers would be visited last by insects, and as the stamens of the last-visited plants would be useless, there being no pistillate plants in bloom to be cross-fertilized, the stamens would tend to disappear "because the loss of useless organs is manifestly advantageous for every organism." — The Fertilization of Flowers, p. 484.

Darwin, on the other hand, supposes that some individuals produced more seed, and consequently less and less pollen, until their stamens finally disappeared. See Forms of Flowers, p. 304.

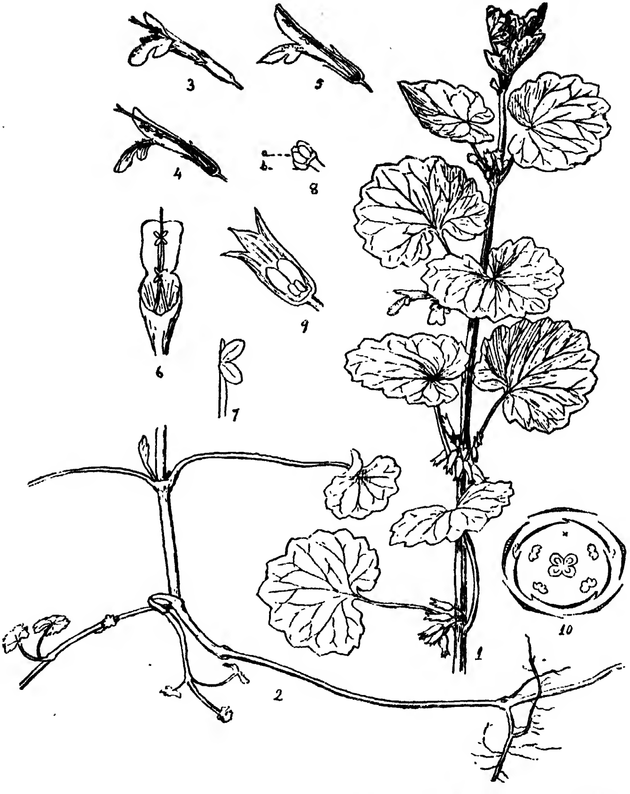

FIG. 27. — Ground-Ivy. 1. Branch with flowers. 2. Base of stem. 3. Flower. 4. Section of same flower. 5. Section of flower in earlier stage. 6. Upper lip, seen from below, the lower lip cut away. 7. Stamen after dehiscence. 8. Ovary: *a*, nutlets; *b*, nectar-gland. 9. Fruit, with section of persistent calyx, two ovules fertilized. 10. Diagram.

the markings on the flower very plainly show, the path to this nectar-gland leads along the under lip. This brings the head and back of the insect against the four anthers upon the upper lip, and he is dusted with pollen. But in the flowers where the anthers are discharging the style is not lengthened or expanded (Fig. 27, 5), and the pollen must therefore be left on the style of an older flower, subsequently visited by the insect (Fig. 27, 4). We have studied this before in the Tropæolum and House-Geranium. The flower is *proterandrous* ; that is, the stamens develop first.

We have little difficulty in placing this plant on our schedule. It is a dicotyledon, gamopetalous, with square stems, opposite leaves, and an irregular flower with a deeply four-lobed ovary, splitting in fruit into four one-seeded nutlets. This combination of characters belongs only to the Labiates.

This family has many flowers, which are wonderfully adapted for cross-fertilization. One of the prettiest of them is Salvia. Our garden Salvia (*S. splendens*) is a fall plant, but I have

often found it flowering in the spring in green-houses.

The tendency to divergence of the anther cells that we have noticed in the Nepeta is carried much further in the Salvia. The connective is long and thread-like, carrying one of the anther cells upward under the upper lip, while the lower cell is suppressed altogether, leaving the lower end of the connective pointing downwards. This arrangement acts like a lever. When a bee visits the flower he pushes the lower end of the connective backwards in entering, and this brings the upper end downward, and causes the pollen-filled cell of the anther to strike his back. The action of the insect may be easily imitated with a pencil, and always delights the pupils.

There are several families which resemble the Labiates very closely, and if examples of them can be obtained they may be compared with the Nepeta, or some other member of this family.

The Borage family contains a good many common weeds, the Stickseed (*Echinospermum Lappula*), Hound's Tongue (*Cynoglossum officinale*), and the disagreeable Beggar's Lice (*Echi-*

nospermum Virginicum). These are summer flowers. They have prickly and barbed nutlets which catch on to the clothing and are very troublesome. The Forget-me-not and Heliotrope are garden flowers belonging to the Borage family, and a pretty common wild flower of the West and South is the Lungwort (*Mertensia*).

Comparing any of these flowers with the one we have been examining, we find that while the nutlets and style are similar, except in the case of Heliotrope which has an undivided ovary, the flowers are regular, with a five-lobed corolla, and the leaves are alternate.

The Vervain family (*Verbenaceæ*) has ovaries which split when ripe into four one-seeded nutlets, but the ovary is not four-lobed, and the style is terminal. The Vervains do not blossom until late in the summer, but cultivated Verbenas can be obtained. This family has also flowers with one-celled and two-celled ovaries, and the fruit of some of them is fleshy and does not split. The leaves are opposite and the flowers generally irregular.

There is another family with two-lipped flow-

ers, closely resembling the Labiates, the Figwort family (*Scrophulariaceæ*). We will take an example that can, however, hardly be called a common weed, if we regard a "weed" as a troublesome and superfluous plant.[1]

LOUSEWORT (*Pedicularis Canadensis*).[2]

This plant flowers in May and June, and is common in shady copses and on the edges of meadows.

The leaves are alternate, simple, and pinnately parted, with the divisions crenate and hairy.

The flowers are arranged in a dense head, which gradually elongates to a spike. They are sessile and each has a crenate bract at the base. Each flower is irregular, with a two-lipped brownish yellow or purplish corolla, which is inserted under the ovary. It has a two-toothed, hooded, curved, upper lip, enclosing the stamens and style. The lower lip is spreading and three-lobed.

The stamens are four in number, and the

[1] Reader in Botany, XI, "Weeds." [2] Appendix, p. 338.

ovary is two-celled, with many ovules on the axis, that is, on a central placenta.

The fruit is a two-celled capsule with many seeds. There is an interesting account by Mr. Gentry, of the fertilization of this flower.[1] The flower, according to his observations, is fertilized by bumble-bees, which alight first on the spreading lower lip, thus coming in contact with the stigma. The length of the tube of the corolla causes the bee to insert not only its proboscis, but its head also, which forces the lips of the corolla apart and causes a shower of pollen from the ripe anthers to fall on the bee's head and back. When the insect leaves the flower, the upper lip springs back to its original position with considerable force, causing another shower of pollen-grains, which, falling on the stigma, may effect self-fertilization. "This operation can be performed artificially, by taking hold of the under lip with the left thumb and forefinger, and pulling the upper lip backward, by the right, and then releasing the hold of the latter; the upper lip springs to its place, spirting the

[1] Nature, Vol. VIII, p. 541.

pollen through the aperture upon the left hand. From the above it is to be seen that the plant has two chances of being fertilized — one, by its own pollen, and the other by that of another. Although the flower seeds abundantly, yet I am disposed to think that it is mainly through the pollen of another that the seeds become perfect."

We can recognize the Figwort family (*Scrophulariaceæ*), to which the Pedicularis belongs, among the group of orders with superior ovary and irregular corolla, by the two-celled ovary, with the placentæ in the axis.

Meadow-Parsnip (*Zizia aurea*).[1]

Here is a member of a very widely diffused family, the *Umbelliferæ*. The first glance at our specimen shows the origin of the name, which signifies umbel-bearing. The flowers are arranged in a compound umbel (Fig. 28, 1), and this is the case with almost every member of the family.

This yellow Zizia is a common flower, generally growing in damp meadows and along

[1] Appendix, p. 339.

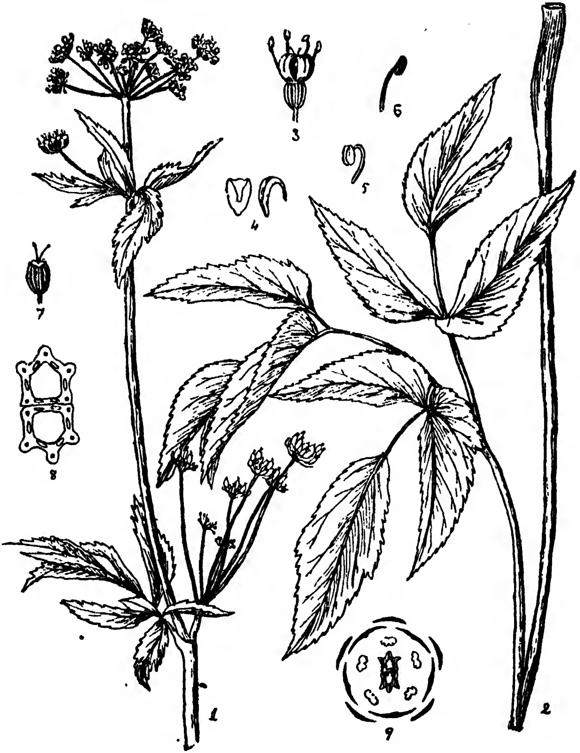

FIG. 28. — Meadow-Parsnip. 1. Branch in flower. 2. Leaf. 3. Single flower. 4. Petals, inner and side view. 5. Stamen before dehiscence. 6. Stamen after dehiscence. 7. Pistil. 8. Section of fruit. 9. Diagram.

streams. In former editions of the Manual it was known as *Thaspium aureum.*

The roots are fleshy and stringy, from an underground rootstock. The leaves are both radical and cauline, alternate and pinnately compound, dilated and clasping at the base, the lower on long petioles, the upper stem-leaves sessile (Fig. 28, 1, 2).

The flower is small, the calyx teeth nearly obsolete, the corolla yellow, inserted with the stamens on an epigynous disk. The æstivation is valvate, with the point bent inwards (*inflexed*), a very common arrangement in this family (Fig. 28, 4).

The pistil is very peculiar (Fig. 28, 7, 8). It is of two carpels, united, but splitting in fruit into two halves. It has ten ribs, which in cross section (Fig. 28, 8) show an oil-tube in each interval and a fibro-vascular bundle in the rib itself that is easily mistaken for an oil-tube. The seeds are flat on the inner face, convex on the outer, and do not separate from the carpel.

There are certain terms employed to describe the fruit of *Umbelliferæ,* which may be found in

Gray's Manual, but which seem hardly worth while to give in such a simple course as ours. The family is difficult because the flowers are extremely alike in the various genera and most of the characters are taken from the fruit. The plants of this family are classified largely by the arrangement of the oil-tubes. This can only be made out with a good simple microscope, and is quite difficult for an inexperienced beginner.

The characters of the Parsley family (*Umbelliferæ*) are flowers in umbels, a polypetalous corolla on top of the ovary, five petals, five stamens, and two carpels, with ribs or wings and oil-tubes in the intervals, splitting in fruit.

The family has been treated in a monograph entitled Revision of North American Umbelliferæ, and diagrams of the fruit of all the genera may be found there.[1]

Field Sorrel (*Rumex acetosella*).[2]

We often see the meadows in summer covered with patches of red, which seem to be more bril-

[1] Revision of North American Umbelliferæ. By Coulter and Rose, Crawfordville, Indiana. [2] Appendix, p. 340.

liant in some places than in others. The color is caused by our little Field-Sorrel, which, beginning its term of flowering with a dull green color, becomes red as the season advances, especially in the fertile flowers, where the akene becomes quite brilliant. We shall find that the brightest portions contain the fertile panicles, which grow together in little patches, while the staminate flowers make a duller bit of color.

Let us examine the plants. Pulling up one by the roots we shall very likely find that it is connected with little new offsets, as in Fig. 29, 1. The stem is smooth, the leaves alternate on the stem, and the lower leaves halberd-shaped. The children know well the pleasant acid taste of the leaves, and like it as well as the sheep do. We used to call it Gentlemen's Sorrel, while the common yellow Oxalis (*O. stricta*) was Ladies' Sorrel. The stipules form a sort of scaly sheath, a character which belongs to the whole family.

The small flowers are diœcious in terminal panicles, without bracts. The perianth is of six separate divisions. In the staminate flowers (Fig. 29, 1, 2, 3) these divisions are all spreading,

but in the pistillate flowers (Fig. 29, 4, 5) the three inner perianth leaves turn inwards and converge over the akene. In fruit they open and are called *valves.* They look exactly like the walls of the ovary, while the akene resembles the seed (Fig. 29, 5, 6).

The anthers are two-celled and the cells diverge after discharging (Fig. 29, 3). They diverge from above, as the cells are fixed at the base. The stamens are much longer than the perianth (*exserted*), the pollen is fine and abundant, and the stigmas are hairy, which characters indicate that the plant is wind-fertilized.

The akene is crowned by a hairy tufted stigma, which is early deciduous. The akene is three-angled and contains a single erect seed (Fig. 29, 6).

Many of these characters are difficult to see on account of the small size of the flower, and the teacher should never require a description of anything which the pupils are unable to see for themselves.

One would not naturally place this flower in the apetalous division. It seems to have two

Fig. 29. — Sorrel. 1. Whole plant, staminate. 2. Staminate flower before dehis-

circles, the calyx and corolla. It is one of those cases where we can know that both the circles belong to the calyx by comparing it with nearly allied flowers, such as Buckwheat, where the calyx is five-parted. Placing it in the apetalous division, we shall put it under the head "Flowers not in catkins," and its alternate, entire leaves, scaly sheaths, and other characters too minute to be studied here, place it in the Buckwheat family (*Polygonaceæ*).

If we can study some Polygonums they will be found interesting. The common Knot-Grass (*P. aviculare*), Tear-Thumb (*P. sagittatum*), and Lady's Thumb (*P. Persicaria*) are some of the commonest ones, but there are many others.[1] The largest and most showy is the Prince's Feather of old-fashioned gardens (*P. orientale*). In these the calyx is five-parted, and the divisions all spreading. The akene is very similar to that of the Sorrel.

[1] Müller gives an extremely interesting discussion of their fertilization. The Fertilization of Flowers, pp. 509–516.

English Plantain (*Plantago lanceolata*).[1]

This Plantain is chosen because it blossoms earlier than our native plant, and can be found in season for our present study.

It is an inconspicuous weed, with spikes of greenish flowers and rosettes of radical leaves. The leaves are lanceolate, giving the name to the species, entire, hairy, and very strongly ribbed. The fibro-vascular bundles are so strong that they can be pulled out in long fibres, and when twisted together will stand a good deal of strain.

The spike is very dense. At first it is round, but later elongates into a spike, with scarious bracts at the base of each flower.

The flowers are small, regular, and complete. The sepals are transparent, with a strong green midrib; the corolla is salver-shaped and persistent, and encloses the ovary in fruit. The corolla, also, is dry and membranaceous.

There are four stamens, which hang out on long, slender filaments. The pollen is light and abundant, showing us that the plant is wind-

[1] Appendix, p. 341.

fertilized.[1] The stigmas are, therefore, as we should expect, long, filiform, and hairy. They mature before the stamens (*proterogynous*). We have had an example of this adaptation before in the Horsechestnut.

The capsule opens crosswise by a sort of lid. The family is known by its regular flowers in spikes, with the parts in fours, and its dry, membranaceous floral envelopes.

INFLORESCENCE.

Where do flower-buds come on the stem?

This question would be a good one to give out to be answered in a following lesson from observation of plants. We shall find that flower-buds come in the same places as leaf-buds, and in their earliest stages cannot be distinguished from them. They are therefore either *terminal* or *axillary*, and we must keep this point continually before us in considering the various forms of flower-cluster that have received specific names.

[1] An interesting discussion of the fertilization of the Plantains will be found in the Fertilization of Flowers, pp. 503–508.

The simplest form of *inflorescence*, or *flower-arrangement*, is the development of single flowers in the axils of leaves, or at the end of the stem. We have called such flowers *solitary*.

When they end the stem, as in Tulip, Anemone, etc., there is no possibility of the flower-stalk continuing to grow; it is terminated. This is therefore called *determinate* or *definite* inflorescence. But when the flowers are in the axils of leaves, new terminal leaf-buds may be developed and the axis may be indefinitely prolonged. We cannot determine where the branch will stop, and this is therefore called *indeterminate* or *indefinite* inflorescence.

Let us now study the plants we have had with reference to the position of their flowers.

When we begin to collect the flowers into clusters, we see immediately that it is difficult to draw a line between those with solitary flowers and those in clusters, for in the latter the flowers often spring singly from the axils of the upper leaves. The leaves simply arise nearer together, and are modified. They are then called *bracts*, but the line dividing a leaf

that is called a leaf, and a leaf that is called a bract, is no more definite than any of the rest of our distinctions. The Lilac is an excellent example of the gradual modification of leaves. Each flower-cluster springs from the axil of a leaf and the leaves grow smaller as we approach the top (Part I, p. 68).

Let us see how our axillary flowers may be grouped, that is, let us examine some of the forms of indefinite inflorescence.

In the Barberry, Wild Cherry, Hyacinth, and Shepherd's Purse we have examples of a *raceme*. The flowers are arranged on the sides of the stem. In the first two examples the flowers spring from the axils of modified leaves, or bracts, but in the Hyacinth the bracts have disappeared or are very minute. The Hyacinth has very short flower-stalks, or *pedicels*. If these were entirely absent the cluster would be a *spike*. We have seen a spike in the Jack-in-the-Pulpit (*Arisæma*), where the flowers are sessile. The common stalk on which all the flowers are arranged is a *peduncle*.

The Shepherd's Purse shows very clearly what

indefinite inflorescence means, for the cluster is at first very short and goes on elongating through the whole season, till it becomes several inches in length. We cannot tell how long it will become.

The Arisæma has a particular name for its inflorescence. It is called a *spadix*, which may be defined as a fleshy spike. The bract which surrounds it is called a *spathe*. Another form of spike, a long cluster with scaly bracts, we have seen in the Willow and Poplar, the *catkin* or *ament*. The flowers are always of a single sex in the true catkin.

We have had no example of a *corymb;* that is, a flat-topped cluster, where the lower pedicels are so much longer than the upper that all the flowers are brought up to the same level. The clusters of many Asters are in this form. We shall see an example of it in the Mountain-Laurel (*Kalmia*).

An *umbel* is a cluster in which all the pedicels start from the same point, like the rays of an umbrella. If we imagine the pedicels absent in an umbel, we shall have a close cluster which is called a *head*. We have a head of flowers in

the Red Clover. There is often a circle of bracts around a head, and this is called an *involucre*, as we shall see in the Dandelion. There is an involucre around the cluster of the House-Geranium also.

When the pedicels branch, we may have compound clusters of all these kinds of inflorescence. We have seen a compound umbel in the Meadow-Parsnip, and this is typical of the whole family to which it belongs, which is therefore called *Umbelliferæ*. A *panicle* is a long, loosely branching compound flower-cluster, like those of many grasses, such as our common Kentucky Blue-grass (Fig. 36, *B*, 1).

Thus far, we have treated only indeterminate clusters, where the flowers arise on the sides of the stem. Let us imagine a solitary flower terminating the stem, like the Tulip, to be accompanied by two younger flowers springing from opposite sides of the stem below it, from the axils of bracts. Then we have a mode of inflorescence which is called a *cyme*. When the leaves are alternate, the lower flowers arise only on one side of the stem, as in Buttercup (Fig. 21, 1).

It is plain that in *determinate* or *cymose* inflorescence, the oldest flowers are at the top, and the order of blooming is a *descending* one. In the indeterminate, on the contrary, the order of blossoming is *ascending*, from below upward.

Some flower-arrangements are very puzzling, as, for instance, in Forget-me-Nots and Heliotrope, where the clusters look like racemes, but are really cymes; but any student who has studied the growth of a Horsechestnut tree (Part I, p. 61) will have no difficulty in understanding them. The axillary flower grows more rapidly, and has a longer pedicel than the terminal flower, and the continued repetition of this makes the cluster look like a raceme, with the younger flowers at the top.

We see *mixed* inflorescence in the Lilac and Horsechestnut, where there are both axillary and terminal flower-clusters. The clusters of Lilac and Horsechestnut are called by the name of *thyrsus*. The same mixed character is present in the Norway Maple, also, where the primary branching is racemose, while the secondary branches are cymes.

The collecting of flowers into clusters makes them more conspicuous and facilitates the collecting of nectar and pollen by insects. It is therefore an assistance to cross-fertilization and an advantage to the plant. Consider the thick clusters of Locust, Lilac (*Syringa*), Cherry, Mountain-Laurel (*Kalmia*), the heads of Clover or the umbels of Meadow-Parsnip (*Zizia*), and think how inconspicuous the flowers would be if they were solitary, and how much longer it would take the insects to visit them. The whole family of Composites have small flowers, which are made noticeable by being collected into heads, and in many cases certain parts of the cluster are specialized for the purpose of attraction, and are otherwise useless, as in the neutral flowers of the Rudbeckia. The same thing occurs in the Hydrangea and Hobble-Bush (*Viburnum lantanoïdes*), where some of the outer flowers are neutral and exist purely for the sake of calling attention with their showy petals to other inconspicuous but fertile flowers. In the Cornel the same purpose is answered by the involucre.

Gray's Lessons, 197–227.

X.

EARLY COMPOSITES.

DANDELION (*Taraxacum officinale*).[1]

THE Dandelion has a very thick tap-root, crowned by a short underground stem. The leaves are coarsely and irregularly toothed, with the teeth projecting backwards (*runcinate*), and they lie on the ground in the form of a rosette (Fig. 30, 1).

The flowers are in close heads, on hollow, smooth scapes. Making a vertical section of one of the heads (Fig. 30, 2), we see that it consists of a collection of separate flowers on a flat receptacle, surrounded by several rows of bracts, the outer rows loosely imbricated and short, the inner row long, narrow, and erect. Each flower has an open, strap-shaped (*ligulate*) corolla, united below into a tube, which is shorter than the open, spreading border.

[1] Appendix, p. 343.

Examining a single flower (Fig. 30, 3), we find that the ovary is inferior and is an akene. Above it is a short stalk (*beak*), on the summit of which is a crown of soft bristles. This represents the calyx, and is called the *pappus*. The corolla is strap-shaped, and shows by the five teeth at the apex that it consists of five united petals. The stamens surround the style and are joined by their anthers (*syngenesious*). The style is two-lobed, and is stigmatic on the inner face of the branches.

The style develops after the stamens, and the arrangement for cross-fertilization is very perfect. The united anthers form a cylinder into which the pollen discharges, and the anther-tube is filled with pollen before the flower opens. During this period, the style remains undeveloped in the lower part of the anther-tube. When the stamens have discharged, the style begins to grow, and the hairs that cover the outer tips of its closed branches sweep the pollen out of the cylinder, and carry it up away from the staminal tube, till it is freely exposed to the visits of insects, collecting pollen or seeking nectar.

Later, the style-branches open, bend back, and stand in the same position in relation to the insects as does the pollen in the younger flowers. As the insect visits many heads in rapid succession, cross-fertilization is almost certain to take place.

In default of insect visits, for the Dandelion blossoms before and after the season of its visitors, self-fertilization is possible. The style-branches continue to bend backwards till they make a spiral, and the stigmatic surface within is rubbed against the pollen on the outer surface of the style.

In fruit, the beak of the ovary lengthens, carrying up the pappus with it (Fig. 30, 6). We can see the use which this serves by making an artificial breeze from our lips and seeing how the fruits fly in every direction. It accomplishes the purpose of scattering the seeds. The akene is roughened with little barbs which hold the fruit where it falls and help it to work into the ground. When we consider how perfect are the arrangements of the Dandelion for fertilization and dissemination, we shall not wonder that the plant is a weed.

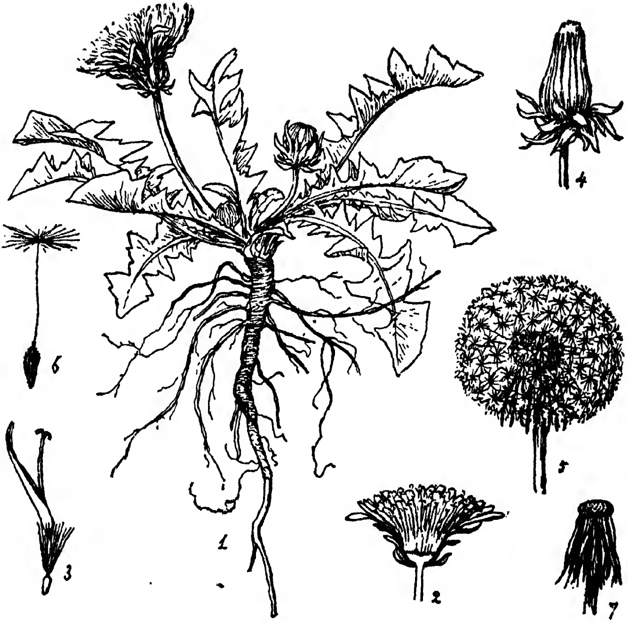

Fig. 30.—Dandelion. 1. Whole plant. 2. Section of head. 3. Single flower. 4. Head after flowering. 5. Head in fruit. 6. Akene. 7. Receptacle after the akenes have blown away.

The involucre is very useful to the Dandelion. It acts the same part to the flower-head that a calyx does to a solitary flower. At first it protects the bud, as the inner row of bracts is folded tightly over the flowers (Fig. 30, 1). As the blossom matures, the bracts are reflexed, so that nothing can be seen from above but the yellow rays (Fig. 30, 2). Later, when the corolla drops off, and the seeds begin to ripen, the involucre closes again around the fruits (Fig. 30, 4), until they are fully ripe, when it turns completely backwards, and the head of winged akenes is exposed to the winds (Fig. 30, 5). Finally, only the naked receptacle is left with the withered involucre below (Fig. 30, 7). The books say that the involucre closes over the florets in rain, but I have often noticed the little yellow suns shining undismayed in the midst of a heavy downpour.[1]

The Dandelion belongs to the great family, *Compositæ*, distinguished by having flowers collected in heads surrounded by an involucre, united anthers, and inferior, one-seeded ovary.

[1] Reader in Botany, XII, "The Dandelion."

This family is divided into two series, the first having tubular flowers (*Tubulifloræ*), the second with ligulate or ray-flowers only (*Liguliflorœ*). The Dandelion belongs to the second series. Our next flower will lead us to a study of the first division.

OX-EYE DAISY (*Chrysanthemum Leucanthemum*).[1]

The love of this plant has been acquired by our generation. Our mothers and grandmothers saw nothing to admire in it. It was called "Whiteweed" and regarded as a pest; its flowers were never made into bunches and worn at the belt or in the bosom. Is the change due to the fact that most of the earlier generation were farmers, and depended on their grass for a part of their sustenance?

However this may be, the Daisy, as we now call it, is universally loved, and will be studied with pleasure.

The stem of the plant is erect and simple, or nearly so, with clasping, cut-toothed leaves.

[1] Appendix, p. 344.

The heads are large and showy, solitary, and terminal. The scales of the involucre are thin and scarious.

The receptacle is nearly flat, and its centre densely covered with small tubular flowers. Let us place one under the lens (Fig. 31). The akenes are ribbed and have no pappus. The corolla is yellow, with a contraction in the middle, as if it had been pinched. It has five teeth, showing that it consists of five united petals. The stamens are like those of the Dandelion, united by the anthers. The style is two-cleft and tufted at the ends of the lobes. As the style grows, these tufts of hairs sweep the pollen from the anther-tube. The pollen, entangled in the hairs, is heaped above the margin, and, if not removed by insects, may dust the stigmatic surface when the style-branches open. Self-fertilization is therefore possible. The different tribes of Compositæ are classified largely by the character of the branches of the style, and, therefore, it is an important point for us to notice.

FIG. 31.—Tubular flower of Ox-Eye Daisy.

All the various forms have a direct connection with the manner in which fertilization is accomplished.

Outside of these *disk-flowers*, as they are called, are the *ray-flowers*. These are like the flowers of the Dandelion, strap-shaped or ligulate. In the Ox-Eye Daisy, however, the rays are pistillate only; in the Dandelion the flowers are all perfect. These marginal florets have lost their stamens and devoted more strength to the showy rays. They perform the service of making the plant conspicuous.

PURPLE CONE-FLOWER (*Rudbeckia hirta*).[1]

A good flower to compare with the one we have been studying, or to substitute for it, is *Rudbeckia hirta*, a plant belonging to the West, but now becoming very common in the East also, by being planted with Western Clover seed. It blossoms later than the Ox-Eye Daisy.

This flower is very showy. The head has a conical disk of dark purple flowers, and orange rays, whence the common name, Black-Eyed

[1] Appendix, p. 345.

Susan. The name *hirta* signifies rough, and comes from the rough-hairiness of the plant.

The involucre of the Rudbeckia is leafy and spreading, instead of thin and papery like the Chrysanthemum, and the receptacle has scaly bracts (*chaff*) among the flowers. The receptacle of the Dandelion and Ox-Eye Daisy are *naked*, that is, without bracts.

The ray-flowers have neither stamens or pistil. They are *neutral*, consisting of nothing but showy corollas, and answer no other purpose than to make the head conspicuous. The style and stigma are undeveloped, and the ovary never ripens. We have here a complete division of labor in the flower-head.

Like the Chrysanthemum there is no pappus. In a previous chapter we stated that when one of the circles of the perianth is wanting, it is generally the corolla (p. 71). In the Composites it is the calyx that is absent. We can learn this by analogy. The corollas are much alike in all the members of the family, but the pappus, or calyx, varies greatly. Sometimes it is a short crown, sometimes a tuft of bristles, and some-

times it disappears altogether, as in the plant we are considering.

ROBIN'S PLANTAIN (*Erigeron bellidifolius*).[1]

This plant reminds us of the Asters, and, indeed, belongs to the Aster tribe.

It is a pretty plant. The tall, flowering stem springs from a rosette of spatulate radical leaves, and bears a few nodding heads with many narrow, violet rays, and a yellow disk.

The involucre has narrow scales in a single row, and the flowers are on a flat, naked receptacle. The pappus is of soft, white, capillary hairs. The style is flat and triangular at the apex and is flattened inside and out, a character belonging to the whole Aster tribe. The Golden-Rods and true Daisies belong also to this tribe of Composites.

PLANTAIN-LEAVED EVERLASTING (*Antennaria plantaginifolia*).[2]

In all the preceding plants, the heads have consisted, wholly or in part, of flowers with a

[1] Appendix, p. 346. [2] *Ibid.* p. 348.

strap-shaped corolla. In the common little Everlasting all the florets are tubular. The heads are therefore called *discoid*, all the flowers being like the disk-flowers in radiate heads.

We shall soon discover that the plants are not all alike in this Everlasting; some heads are small and pointed; others are larger and flatter at the top. The former are a purer white and the styles protrude; the latter have exserted brownish or reddish stamens. The plants are, in fact, diœcious.

Gathering specimens of both kinds of heads and placing them under a lens, we find many differences between them. The white, papery scales of the involucre are broad and obtuse in the heads with staminate flowers, and narrow and acute in the pistillate heads.

The staminate flowers have a pappus thickened towards the top, like the antennæ of certain insects, whence comes the name of the plant, *Antennaria*. The fertile flowers have a fine pappus of the same size throughout, and the hairs are united at the base and fall in a ring.

The corolla of the sterile flower is spreading

at the throat, and much wider than the corolla of the fertile flower, which has a very slender tube. Perhaps the staminate flowers may need a wider corolla, in order that the pollen may be the more easily removed. No doubt all the differences have some significance, but the plant has not been carefully studied.

The anthers of the Antennaria are tailed at the base, making them arrow-shaped. The presence or absence of tails in the anthers is used in classifying the various tribes of Composites.

One other difference between the fertile and sterile flowers is easily explained. The style is long and two-cleft in the fertile flowers, but short and nearly simple in the sterile ones. This is because the style and stigma are useless in the staminate flowers, and therefore undeveloped.

Golden Ragwort (*Senecio aureus*).[1]

This common plant has the distinction of belonging to the largest genus known.

It is a tall, showy herb, with golden corymbed heads. Each head has a few pistillate rays. The

[1] Appendix, p. 349.

pappus is of soft, white, capillary bristles, and plays an important part in scattering the fruits.

The fertilization takes place as in other Composites, the pollen being swept out of the anther-tube by the hairy tips of the style-branches. which in this case are capitate.

We need never mistake the family to which all these plants belong, because it is distinguished by such obvious characters. The corolla is of united petals, and the ovary is inferior, so that we place it at once, at the beginning of the gamopetalous division. The flowers in heads, surrounded with an involucre, the united anthers, and the one-celled ovary, with a single erect ovule, mark the Compositæ. The only family with which it could be confounded is the Teasel family, *Dipsaceæ*, which also has the flowers in heads, surrounded by an involucre. In this family, however, the stamens are distinct and the seed is suspended. The Scabious of our gardens is the only plant we shall be likely to meet with belonging to the Teasels.

We will sum up the characters that must be carefully noted in the analysis of a Composite,

since they differ from any family which we have before studied.

We must note the grouping of the florets into variously shaped heads, as well as the arrangement of the flower-heads themselves. The texture, shape, and color of the involucral scales must be described, and the arrangement of these scales in the bud.

A vertical section of the whole head must always be made, and the kinds of flowers in the head described, whether both rays and disk-flowers are present, or whether the heads are wholly radiate or wholly discoid. In some Composites the flowers are not all alike in the head, even when all are tubular, as in our common Tansy, where some of the marginal flowers are pistillate only, and have an oblique, three-toothed border.

The receptacle, the part of the flower-stalk that holds the whole head, must be carefully described. We must notice its form, surface, and whether it has chaff among the flowers, or is naked.

Coming to the separate flowers, we must

describe the pappus and the shape of the corolla, and must examine both ray-flowers and disk-flowers in making our descriptions. The anthers are sometimes appendaged, having tails at the base; sometimes they are tailless. They are always united into a tube and dehisce introrsely.

The ovary is always an akene, variously ribbed and roughened. The style-branches differ greatly and the characters derived from them are much used in classification. The stigmatic surface is always on the inner faces of the style-branches.

The Composite family contains more species and genera than any other. This is probably due to the perfection of the arrangements for cross-fertilization and dissemination.

It is an advantage to the flowers to be collected into heads, because it renders them more conspicuous and enables the insects to visit them more quickly; and because, also, as the involucre plays the part of calyx to the whole head, the separate flowers can dispense with these coverings, which have become transformed into various forms aiding the dissemination, as the pappus in the Dandelion, which acts as a wing,

and the hooks in our common Bur-Marigold, which cling to the fleece of animals, and cause the fruit to be transported from place to place.

The nectar is very accessible, and the flowers are therefore visited by a great variety of insects. The flowers are proterandrous, and the pollen is swept out of the anther-tube by what Müller calls the *sweeping hairs* on the style. When the style-branches open, exposing the stigmatic surface, they are apt to be fertilized with pollen from the younger flowers.

In many genera self-fertilization is possible, in the absence of insects, by the gradual recurving of the branches of the style till they are brought in contact with the pollen.[1]

The Seed.

The formation of the seed completes the cycle of the life of the plant. We planted a seed and watched it grow into a seedling; we studied the development of root and stem and leaf, and saw the plant blossom. We learned the parts of the flower and observed the ovary mature

[1] The Fertilization of Flowers, pp. 315–318.

into the fruit, and now, within the fruit, we come again to the seed, from which will spring a new individual to repeat the same changes, and produce, in its turn, new descendants.

A review of what we learned in the section on Seedlings will be interesting and profitable, and we can add to the points which we then noted.

The seed is the developed ovule and much of the terminology of the parts is the same. According to the direction of the ovules or seeds in the pod they are called erect, or horizontal, ascending, or pendulous, and these terms hardly need more explanation. If the position is seen it can be described by the pupil.

More difficult is the description of the kind of seed, or ovule, according to the manner in which it develops. Let us take a Bean and see if we can make its structure clear. It is not one of the simplest form of ovules, but it can be procured at any time, and if we understand its structure thoroughly it will be easy to understand the rest.

First, let us take an unripe Bean-pod for our

examination. We already know that the ovules, which are here partly developed into seeds, are organs which generally originate at the margins of the carpel, or seed-leaf. We have, in the bean, a simple carpel bearing a row of ovules on each incurved margin. The pod may split either on these joined margins (*ventral suture*) or on the midrib (*dorsal suture*). Let us split it at the more natural place, where the margins join, and examine the arrangement of the seeds.

Each Bean has a seed-stalk, from which it separates when the seed is ripe. The place where this stalk separates leaves a scar which is in the middle of a ripe Bean. This is called the *hilum*. The end of the attached stalk on the upper side of the seed is the place where the seed-coats originate (*chalaza*), and here if we cut the seed open we shall find the plantlet or embryo. Just opposite the point where the embryo joins the seed-stalk we should expect to find the opening where the pollen-tube descended to fertilize the ovule. It would be there if the seed were perfectly straight, but one side of the ovule in the Bean is more developed

than the other, and the orifice has been bent around, until it is brought nearly up to the point where the seed-stalk joins the placenta. In the ripe Bean there is a tiny raised dot close to the scar left by the seed-stalk. This closed orifice is the *micropyle* of the seed.

An ovule, or seed, in which the seed-stalk is adnate to the ovule for half its length, so that the hilum, or scar, comes in the centre of the seed, as in the Bean, is called *amphitropous*. It is not a very common kind of ovule. A far more common kind is one where the adnate seed-stalk, which is called the *rhaphe*, runs along the whole length of the seed, making it completely inverted on its stalk, in such a manner that the real base of the seed where the coats originate is apparently at the top, and the micropyle at the base, close to the scar. This is an *anatropous* ovule, and may be seen in the *Ranunculaceæ*, the *Violaceæ*, *Rosaceæ*, and many other families.

Two other kinds of ovule that have received special names are not united with the seed-stalk, or rhaphe. The simplest form is the straight ovule (*orthotropous*), which is erect, with the

opening at the apex, as in the Sorrel, which we have just studied. The seeds of Chickweed are *campylotropous*. Here the ovule starts straight, but one side grows faster than the other, so that the micropyle is brought close to the hilum.

The difference between this form and the seed of the Bean is not very great, for, as we have seen, one side of the ovule is more developed than the other in the Bean also; but, in this case, the rhaphe is partly adnate to the seed and part of the curvature is caused by the inversion of the ovule on the stalk, while in the true campylotropous seed the whole curvature is caused by the unequal growth of the ovule.

These various types of seeds have many intermediate forms, difficult to classify. They cannot be understood, in any case, by a mere description, but a study of the development of an ovule to a seed will make the matter plain. Illustrations will clear up the subject also, and these may be found in the text-book.[1]

Making a section of our Bean, we find that it consists of an embryo covered with two coats,

[1] Gray's Lessons, pp. 110–112.

an outer and inner coat. The outer coat has been called the *testa*, from a word which means shell, because it is often very hard. The inner coat is generally thin and delicate. Not every seed has two coats.

The whole body of the seed inside the coats is called the *kernel*. We have already learned that some seeds have all the food for the seedling packed away inside the plantlet (*endosperm*), and that some have outside material from which to draw their first nourishment (*perisperm*). We called the former seeds *exalbuminous* and the latter *albuminous*, but the names are not very suitable, because the food is just the same in both cases, only in one case the plantlet has taken it up before the seed is ripe, and in the other case it absorbs it after germination.

We have already learned the parts of the embryo. One little point we may add to the description of our Bean plantlet: the caulicle is placed against the edges of the seed-leaves (*accumbent*). This is used as a character in the classification of the Cress family (*Cruciferæ*), where the caulicle is disposed in two ways, the

one we have just noticed, and another where it is placed against the back of one of the cotyledons (*incumbent*).

The outer coat of the seed is often developed into appendages, which are useful in aiding the seeds to scatter more widely. The seed of Milkweed has a tuft of soft hairs, and so has that of the Cotton plant. Sometimes the outer coat of the seed is roughened to catch the ground. We must not confound these cases with such fruits as the akenes of the Dandelion, where the hairs belonging to the calyx, and the roughness of the ovary, perform the same office for the seed.

We have seen seeds also where the rhaphe was developed so as to be very conspicuous, as in the Bloodroot and Corydalis. An appendage surrounding the whole seed, is called an *aril*. The aril best known to us is that of the Nutmeg seed, which is *mace*. These outgrowths are often attractive to birds and help dissemination by causing the seed to be eaten.

A chapter on the subject of dissemination will be found in the accompanying Reader.[1]

[1] A Reader in Botany, XIII, "How Seeds Travel."

XI.

EARLY SUMMER FLOWERS.

THERE are many flowers in early summer belonging to the Pulse family (*Leguminosæ*). In cultivation we have the Wistaria (*W. Sinensis*), the Locust (*Robinia*), Laburnum (*Cytisus*), Clover (*Trifolium*), Bean (*Vicia*), Pea (*Pisum*), and many others, while the Lupine (*Lupinus Perennis*), Ground-Nut (*Apios Tuberosa*), Vetch (*Vicia sativa*), and, on the coast, the Beach-Pea (*Lathyrus maritimus*), are growing wild. We will take the Locust, as one of the simplest of these flowers, and examine its structure.

LOCUST (*Robinia Pseudacacia*).[1]

The Locust is a common tree in cultivation, and is often found escaped from gardens and thoroughly naturalized in New England. It is

[1] Appendix, p. 350.

a native of the Middle States. It is a large tree with furrowed, ash-colored bark. The leaves are pinnately compound, smooth, and thin, and of a delicate pale green color, without stipules, or with stipules converted into spines. There is a very interesting peculiarity about the buds of this tree. They are hidden beneath the leaf-stalks, which fit over them like extinguishers, and are only revealed to view when the leaves fall and the tree is in its winter dress, with the buds fully formed for the next spring.

The white and fragrant flowers are in long, hanging racemes in the axils of the leaves.

The flowers are complete, with a five-lobed calyx and a corolla of five petals. These petals are very dissimilar and have received special names. The large conspicuous outer petal, which enfolds the others in the bud, is called the *standard* (vexillum), Fig. 32, 3, *a*. The lateral petals are the *wings* (alæ), *b*, and the two lower petals unite to form the *keel* (carina), *c*, so named from its resemblance to the prow of a boat. The whole corolla is called *papilionaceous*, from a fancied resemblance to a butterfly. The wings

of the corolla are perfectly free in the Locust. We shall see that in other members of the family they are united in various degrees.

The stamens are united by their filaments into a tube, excepting the upper stamen, which is free. Within them lies the nectar, approached only through this split tube of filaments, at the base of the standard. When the stamens are united into two sets they are termed *diadelphous* (in two brotherhoods), although here one of the sets consists of a single free stamen.

The pistil is a long, linear pod, consisting of one carpel. The style is curved and is enclosed within the staminal tube in the keel of the corolla. When an insect alights on the corolla to suck the nectar, he finds the keel and wings a convenient standing-place. They are depressed by the weight of his body, but the stamens and style, being stiff, do not bend; they emerge from the keel, and are rubbed against the under side of the body of the insect. When the bee flies away, the elasticity of the petals brings them back to their former place, enclosing the stamens and style, and the action is repeated until the

petals lose their power of returning to their original position. As the style is longer than the stamens, cross-fertilization is likely to take place.

This is the simplest arrangement for fertilization in the family. The wings are free, and the stamens emerge when the keel is depressed by the weight of the insect's body. Other examples are Wistaria, Laburnum, and Clover.

The Laburnum (*Cytisus Laburnum*) has monadelphous stamens, and the nectar is entirely enclosed in a gland, so that the insect must pierce this gland with its proboscis in order to obtain the nectar. According to Müller,[1] it is so rich in honey that a column of liquid will ascend a fine glass tube inserted in the gland. Müller says, also, that the hairs around the stigma protect it from contact with insects in the younger flowers. In older flowers the hairs have withered and the stigma is freely exposed, while the style at the same time bends more towards the centre of the flower and away from the stamens. This ensures cross-fertilization.

[1] Fertilization of Flowers, p. 193.

The Laburnum has a depression in each wing near the base, which fits into a corresponding depression in the keel, and causes the parts to return more quickly and firmly to their places after an insect visit.

The Red Clover (*Trifolium pratense*)[1] has all the petals united into a tube, which is long enough to exclude short-lipped visitors from the nectar, so that it is principally fertilized by bumble-bees. But hive-bees often bite through the corolla and thus feloniously reach the nectar.[2]

The parts of the flower are kept in place, as in the Laburnum, by the lobes on the wings, which embrace the column of stamens and fit beneath the standard, bringing the parts back to their original position when disturbed.

The stamens are diadelphous, and the tenth free stamen is turned to one side, so that it is not in the way of the proboscis of the insect thrust down to reach the nectar. The style is

[1] Appendix, p. 352.

[2] Cross and Self-Fertilization, pp. 425–435. Reader in Botany, XIV, "Habits of Insects."

longer than the anthers, and thus self-fertilization is rendered more difficult.

The White Clover has a shorter tube and is visited by all kinds of bees. Darwin covered patches of these plants with a net and found that they seeded very scantily.[1]

All these flowers have essential organs which simply emerge from the keel when it is depressed and return to it when released. Other papilionaceous flowers have a much more complicated mechanism, as we shall see.

Common Pea (*Pisum sativum*).[2]

We have already studied the germination of this plant, and know something of its habits.[3] The leaves are alternate and compound, ending in a branched tendril. We can find leaves where there are more leaflets and fewer branches to the tendril, and sometimes we find a leaflet directly opposite a tendril, showing that the tendrils are modified leaflets. The large stip-

[1] Charles Darwin. On the Agency of Bees in the Fertilization of Papilionaceous Flowers. Gard. Chron. 1858. Page 828.

[2] Appendix, p. 353.

[3] Outlines, I, pp. 20–27.

ules are a very conspicuous part of the leaf in the Pea. The flowers spring from the axils and are solitary or with several from each axil.

The corolla is wonderfully fitted together. The standard has two hard swellings at its base, under which fit two processes of the wings, little depressions or pouches, which fit into corresponding depressions in the keel and cohere with them (Fig. 32, 3). These processes hold the parts of the flower firmly in place, and when the keel is depressed cause it to spring quickly to the same place as before. It takes a very strong insect to overcome the resistance of the parts, and the flower is seldom visited, so that here it is really disadvantageous to it to have its flowers so firmly closed.[1] It was probably adapted in its native haunts for some special insect.

The stamens are diadelphous, with the nectar between the tube of filaments and the pistil.

The style is incurved, shaped like a sickle, and bent so strongly that the stigma points nearly to the base of the flower. On the inner side

[1] The Fertilization of Flowers. Müller. Pages 213–214.

of the style is a thick brush of hairs (Fig. 32, 4, 5).

The stamens dehisce before the bud opens, and wither, so that the upper part of the keel, the stigma, and the brush of hairs on the style are thickly covered with pollen. The edges of the opening in the keel through which the style passes are elastic; they press tightly against the style and when it returns into the keel the pollen is swept out and remains outside. This process is often repeated, and the filaments, meanwhile, enlarge and push up the pollen until all has been swept out. Self-fertilization takes place, for the pollen of the same flower is rubbed on the stigma by the action of the insect. The Pea is also self-fertile without insect aid, for the stigma becomes dusted with the pollen while still in the bud. It seems a little strange that the Pea should be perfectly self-fertile, in view of such an elaborate mechanism, and there are many flowers nearly related to it that are entirely dependent on insects for their fertilization.

The Kidney Bean (*Phaseolus vulgaris*) is such a flower. It blossoms later than the Pea, and we

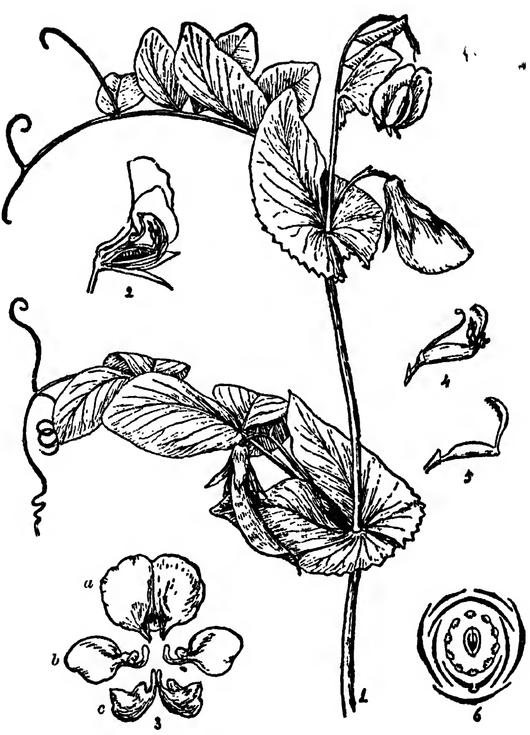

Fig. 32. — Common Pea. 1. Branch with flowers. 2. Section of flower. 3. Petals taken apart: *a*, standard; *b*, wings; *c*, keel. 4. Stamens and style, the upper stamen raised. 5. Pistil. 6. Diagram.

can hardly compare it at this particular lesson, unless we have planted Beans in the schoolroom for the purpose. Its mechanism is much the same, but self-fertilization is impossible, because the peculiar twisted style projects far beyond the stamens. Darwin tried numerous experiments in covering the plants with a net and proved that they were hardly, if at all, self-fertile.[1] When he imitated the action of the bees he obtained good pods.

The Beach Pea (*Lathyrus*) and the Vetches are similar to the cultivated Pea in their arrangement.

LUPINE (*Lupinus perennis*).[2]

This pretty wild flower has a very peculiar apparatus for pressing out the pollen. It is called by Müller the piston mechanism.[3]

The stamens are monadelphous and of two sorts, differing in their uses. The five outer stamens are longer in the bud and the anthers are much larger. They produce a great deal of

[1] Cross and Self-Fertilization, p. 160.

[2] Appendix, p. 354.

[3] The Fertilization of Flowers, p. 187.

pollen and dehisce while the flower is still in the bud. The pollen is left in the apex of the keel, just as it is in the Pea. The large oblong anthers then wither back to the lower part of the keel, and the inner anthers begin to grow. These are club-shaped, and push the pollen before them with their tips, till it is tightly packed in the apex of the keel. When the keel is depressed by an insect visitor the pollen is pushed up in a narrow ribbon by the club-shaped anthers. This process can be repeated several times, for the elasticity of the petals brings the parts back to their places, and the elastic edges of the keel prevent the pollen from being carried back again.

The style is surrounded by a collar of hairs, which prevents the stigma from being fertilized with its own pollen.

One other type of structure should be mentioned. Certain flowers have their essential organs confined under pressure, and these explode suddenly when they are visited by insects and scatter the pollen. The common Medick (*Medicago lupulina*) is an example of this.

A few of our flowers belonging to Leguminosæ are not papilionaceous. The only one of them often met with is the Honey-Locust (*Gleditschia*).

The family will be found in the perigynous group on the schedule. The corolla and stamens are inserted on the calyx around the ovary. In some of the flowers it is rather difficult to see this without a very careful section, as the stamens and petals are inserted near the base of the calyx, and the ovary is free. A careless glance gives one the impression that the petals and stamens are inserted beneath the ovary. The simple, free pistil, becoming a legume in fruit, and the monadelphous or diadelphous stamens, make the family quite unmistakable. The leaves are usually compound. They have a look that we shall soon learn to recognize as a leguminous look, although it is hard to describe. The leaflets are smooth, entire, and rather thin.

Blue Flag (*Iris versicolor*).[1]

A common flower in our wet meadows in June is the Iris, or Blue Flag.

[1] Appendix, p. 355.

The leaves are parallel-veined and sword-shaped, folded on the midrib, with the inner surfaces coherent for about half their length. The lower half is open and clasps the stem or the next leaf. Because of this straddling, such leaves have received the name of *equitant*.

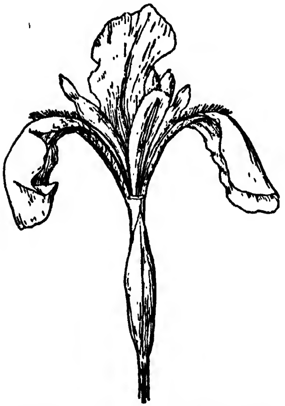

FIG. 33.—Iris, three perianth leaves removed.

The flowers are large and showy, purple blue, variegated with yellow and green, and with dark veins on the sepals. The petals are erect and unmarked. Following the nectar-guides to the base of the flower, we find the nectar secreted in the lower portion of the perianth.

The stamens are three, and are covered by the three overarching divisions of the style. They are extrorse, erect, and linear.

The style is quite peculiar. Its divisions are petaloid, and of the same color as the perianth.

The stigma is near the apex of each division of the style, and is in the form of a lip, or shelf, stigmatic on the upper, but not on the lower side. These stigmas are just above the stamens. An insect, creeping into the flower after nectar, will follow the guides on the outer perianth-leaves and, in so doing, will touch the stigmatic surface on entering, and then be dusted with pollen from the overarching stamen. Coming out, he will touch the outer non-stigmatic surface of the shelf, and will not fertilize that flower, but the next which he enters. Self-fertilization is, therefore, wholly precluded.

We have already studied the family to which the Iris belongs. The parallel-veined leaves, and the flower with its parts in threes, show that we have a monocotyledon. It has a colored perianth, an inferior ovary, and three stamens, and we shall therefore place it in the Iris family (*Iridaceæ*) on our schedule.

Another flower belonging to this family, which flowers at the same time as the Iris, is the Blue-eyed Grass (*Sisyrinchium*). The yellow Star-grass (*Hypoxis erecta*) will be a good flower

to compare with it. This belongs to the Amaryllis family.

Many of the Lily family flower in June. The Star-of-Bethlehem (*Ornithogalum umbellatum*), the Solomon's Seal (*Polygonatum*), the various Smilacinas, the Wild Lily-of-the-Valley (*Maianthemum Canadense*) the Clintonia, the Greenbriar (*Smilax*), the Indian Cucumber-Root (*Medeola Virginica*), and the Indian Poke (*Veratrum viride*) will supply material for as much study of the Liliaceæ as can be desired.

Mountain-Laurel (*Kalmia latifolia*).[1]

One of the most beautiful of our June flowers is the Mountain-Laurel. One who has seen a hillside completely covered with this plant in flower, or a thicket with the rosy clusters shining out among the other shrubs, will always remember it as one of the floral displays of the world.

The leaves are evergreen, smooth, shining, and clustered at the ends of the branches, surrounding the full corymbs of pink and white flowers.

The corolla is of a peculiar shape, wheel-shaped at the base, with ten spokes that end in

[1] Appendix, p. 356.

little pockets in the bell-shaped, plaited, five-lobed border. It is contracted at the base into a short, narrow tube. It is beautifully tinged with rose-color, or nearly white, and has a wavy rose-colored line at the mouth of the tube. The ten anthers, held by elastic filaments which fly up when released, fit into the pockets of the bell. This release is accomplished by bees, which suck the nectar in the base of the tube and, in so doing, pull the filament, which suddenly flies back from its constrained position, throwing the pollen against the insect, and often to a considerable distance from the flower.[1]

[1] "When the anthers are liberated from the pockets in the corolla, the stamens suddenly straighten, and throw jets of pollen often for a foot or more, 'acting,' as Professor Gray used to say, 'like a boy's pea-shooter.'

"Many times when the dew was on, I have seen the common honey-bee and other Hymenoptera about these flowers. When the bee alights on the flower, the style comes up between the legs where they join the body, or sometimes farther back against the abdomen.

"In this position they turn round as though they were balanced on a pivot, generally inserting the tongue outside of the filament, and, while doing this, pull the stamens with their legs towards the centre of the flower, releasing them and subsequently receiving the shots of pollen on their own body. A single visit from an insect is sufficient to release all the anthers." — W. J. Beal, in Amer. Nat., Vol. I, p. 257.

The pollen is discharged from the holes in the apex of the anther, and is quite safe from disturbance, as long as the anther has its head buried in the pocket. Professor Beal found that the anthers were seldom released when the flowers were covered with a net.

We have already studied the Azalea and Epigæa, belonging to the Heath family. In this order the ovary is sometimes inferior, sometimes superior. The anthers dehisce through pores in the apex of each cell. The Epigæa and a few other members of the family have anthers which dehisce throughout their whole length.

Other members of the Heath family that flower at the same time as the Laurel are the Pyrolas, the Huckleberry, Blueberry, Cranberry, and Deerberry, the Andromeda, and the interesting parasites, Indian-Pipe and Beech-Drops.

BUSH-HONEYSUCKLE (*Diervilla trifida*).[1]

The Honeysuckle family is one that is well represented in June by the various Viburnums, the Elder, the Honeysuckles, and towards the

[1] Appendix, p. 358.

north the exquisite Linnæa Borealis. We will take a common plant as our specimen for study, the *Diervilla trifida*, or Bush-Honeysuckle. We have another Diervilla (*D. Japonica*), known as Weigelia, which is very common in our gardens, and may be substituted for the wild species, if desirable.

The Wild Diervilla is a shrub, growing from one to four feet high. It has a creeping root-stock throwing up long, simple shoots, becoming branched near the top. The leaves are opposite, without stipules, which is a character belonging to the whole family.

The flowers are in terminal and axillary cymes, near the summit of the stem, generally three-flowered, whence the specific name, *trifida*. The corolla is funnel-shaped, with the lower lobe larger, deeper yellow, and crested, so that we naturally look at its base to find the nectar, and see there a small gland. The corolla is on the summit of the ovary, and the stamens are united with it. The filaments are clothed with soft hairs, forming a protection from the rain for the nectar, and perhaps keeping out unwelcome guests also.

The style is at first straight, but in the older flowers is declined. The stigma is capitate.

The corolla changes in color after fertilization from honey-yellow to a deep yellow. This change of color may assist the bees to save time by showing them the flowers which are too old to contain nectar, a point that we noticed in connection with the Horsechestnut, p. 122.

The change of color is more decided in the garden Weigelia.[1] It would be interesting for the pupils to watch these plants to determine whether insects ever visit the flowers after the change of color occurs.

As the flower has an inferior ovary it will come among the first families in our gamopetalous division, where there are few to choose from, and we shall recognize the Honeysuckle family (*Caprifoliaceæ*) by its having the parts in fives, a tubular corolla with the stamens on its tube, and opposite leaves without stipules.

Several Viburnums flower about this time, among them Viburnum Opulus, the bush known to country people as the High-bush Cranberry,

[1] Reader in Botany, XV, "Colors of Plants."

and used as a substitute for that fruit. The outer flowers of the large cyme are neutral, that is, lacking the essential organs, and they have large, pure white corollas, which render the whole cluster conspicuous to insects. The same thing occurs in the Hobble-Bush (*V. lantanoides*), and in the Hydrangea, belonging to the Saxifrage family. These sterile flowers, useless in themselves, are nevertheless useful to the whole cluster in attracting insects.[1] The Snowball tree is a variety of V. Opulus with the whole cyme turned into showy flowers, and therefore quite sterile. This state of things, of course, could only exist in a plant under cultivation.

The family most nearly resembling the Honeysuckle family is the Madder family (*Rubiaceæ*), of which we have had an example in Houstonia. The Bedstraw (*Galium*) and the pretty Partridge-Berry (*Mitchella*) are in flower in June, and may be used for comparison. We distinguish the Rubiaceæ by the opposite leaves, connected with interposed stipules, in

[1] Fertilization of Flowers, p. 291.

Houstonia and Mitchella, and the whorled leaves in Galium, for in the Honeysuckle family the leaves are alternate and without stipules.

The Partridge-Berry has two flowers with twin ovaries on each flower-stalk, making the familiar scarlet berry, crowned by the double calyx, which remains on the plant all winter.

The flowers are dimorphous, as in Houstonia, and are occasionally diœcious. Dimorphous flowers are more common in Rubiaceæ than in any other family. Darwin discusses them very fully in Forms of Flowers.[1]

[1] The Different Forms of Flowers or Plants of the Same Species. By Charles Darwin. D. Appleton. Page 132.

XII.

EARLY SUMMER FLOWERS. — *concluded.*

We will now turn to another group of plants among the Gamopetalæ, those with superior ovary and regular corolla, and will take first a characteristic specimen of the Convolvulus family.

Hedge Bindweed (*Convolvulus sepium*).[1]

This is a common trailing and twining plant with arrow-shaped or halberd-shaped leaves. The flowers open in the morning and close at night. The corolla is rose-colored or white, of a very delicate texture, and trumpet-shaped. It is convolute in the bud, and this form of æstivation gives the name to the genus and to the family.

The stamens are five in number, on the corolla, and conniving closely around the style. The only openings to the nectar, which is se-

[1] Appendix, p. 359.

creted by a yellow glandular disk surrounding the ovary, are between the bases of the filaments.

Looking down into the flower we can see these five little cavities, often filled with the shining nectar. This is well protected from rain by the hairs on the bases of the filaments, as well as by the connivance of the filaments themselves.

The anthers are innate and dehisce on the margins and the pollen is rubbed off by an insect delving for the nectar. The style, ending in a two-parted stigma, overtops the stamens. Self-fertilization is not likely, therefore, to take place.

The flower is not visited by many insects. Müller says it is visited by a night moth, *Sphinx Convolvuli*.[1] I have seen a bumble-bee sucking the nectar who visited all the open flowers in a large bed in the space of a few minutes.

The Convolvulus family may be known, among the gamopetalous families with superior ovary and regular flowers, by possessing chiefly

[1] Fertilization of Flowers, p. 424.

twining or trailing herbs with a five-lobed, convolute corolla. The leaves are alternate. In the Dodder, a parasitic plant, the corolla is imbricated.

POTATO (*Solanum tuberosum*).

The potato fields begin to blossom in June, and will afford us an example of another order, the Nightshade family (*Solanaceæ*), belonging to this group with superior ovary and regular corolla.

The Potato has a very pretty flower, with its pure white corolla and golden stamens, and when picked will sometimes be admired by people in ignorance of its identity.

The herbage is hairy and coarse, and the leaves are pinnate, with minute leaflets intermixed. The clusters of flowers are terminal, but appear to be axillary. They are forked at the base, and the younger flowers arise as lateral branches of the older one. The clusters are therefore cymose.

The calyx is five-parted, with linear-lanceolate divisions. The corolla is wheel-shaped,

valvate in the bud, and plaited, reminding us of the Convolvulus.

The stamens have very short filaments and large oblong anthers, closely surrounding the style. The pollen is discharged through a hole in the apex of each cell (Fig. 34, 2, 4, 5).

The ovary is two-celled with the large placentæ in the axis. The style is curved downwards and has a capitate stigma (Fig. 34, 3, 6, 7).

The fruit is a round berry, with persistent calyx, generally known as a potato-ball. In a search through three fields this summer I failed to find a single fruit, and the illustrator of this volume could not find one to put into her illustration. This is due probably to cultivation, the fruit having become unnecessary to the well-being of the plant.

The arrangement of the stamens and style seems to aim at cross-fertilization, for the flower stands horizontally on the axis, and the lower stamens project beyond the upper, but it secretes no nectar, and is not much visited by insects.[1] In the specimens examined in the sterile fields

[1] Fertilization of Flowers, p. 425.

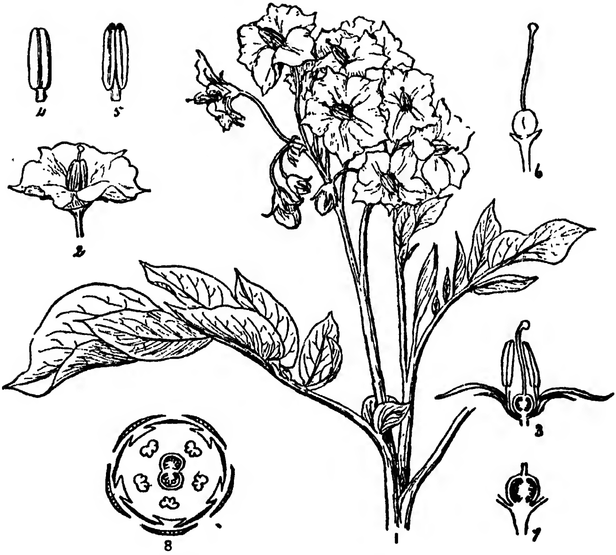

FIG. 34. — Potato. 1. Flowering branch. 2. Single flower. 3. Vertical section. 4, 5. Back and front of anther. 6. Pistil. 7. Section of ovary. 8. Diagram.

above referred to, the anthers appeared to be also sterile.

A common Solanum, that may be studied instead of the potato blossom, is the Nightshade (*S. nigrum*).

The Tomato (*Lycopersicum esculentum*)[1] is a nearly related plant. Here the clusters of blossoms are lateral, and not even opposite a leaf. But if we examine the young forming flower-buds we shall find them terminal, with an axillary bud in the axil of the nearest leaf, which in its development pushes the flower-cluster to one side. The flower-stalk is united to the stem of this branch, and the growth of united stalk and stem carries the flower-cluster up away from the neighboring leaf-axil. The ovary of the Tomato differs from the typical ovary of the Nightshade family in having the carpels increased in number, and is often many-celled.

The fruit is a berry with the principal part of the eatable pulp developed from the large placentæ.

The Nightshade family is distinguished from

[1] Appendix, p. 360.

the Convolvulus family by having numerous ovules on the axis, instead of a pair of erect ovules in each cell. The corolla is imbricated or valvate, instead of being convolute.

The Borage family has a regular corolla, alternate leaves, and a simple style. We have already treated this family in connection with the Labiates, p. 194.

The Phlox family (*Polemoniaceæ*) has a regular corolla with alternate leaves. It may be recognized by the three-cleft style and three-celled ovary. There are several Phloxes common in our gardens, of which the Phlox Drummondii is perhaps the earliest. The leaves of this plant are opposite and sessile, the corolla salver-shaped, and the stamens inserted very unequally on its tube.

We will examine two families in this group, the Milkweed family (*Asclepiadaceæ*) and the Dogbane family (*Apocynaceæ*). These orders have herbs with milky juice, and one-celled ovaries becoming follicles in fruit.

BUTTERFLY-WEED (*Asclepias tuberosa*).[1]

We have chosen this Asclepias for our example because it is the first to blossom, and comes into flower the latter part of June. The Milk-weeds generally do not blossom till July. They are all so much alike, however, that the study of any species will show the points that call for especial notice in the rest.

The Butterfly-Weed differs from the others in being without milky juice. Our common Milk-weeds (*A. cornuti, A. phytolaccoides, A. quadrifolia*) have an abundant milky juice, which is very sticky and makes the flowers unpleasant to pick.

The leaves of the Butterfly-Weed are opposite, simple, and lance-oblong, on erect stems which branch near the top. The showy flowers are in simple terminal umbels, with an involucre of tiny, awl-shaped bracts (Fig. 35, 1). They are complex in their structure and wonderfully adapted to fertilization by insects.

The calyx is free and very deeply parted into

[1] Appendix, p. 361.

five small reflexed divisions. The corolla is also free, reflexed, five-parted, and of a brilliant orange-red color. Joined to its base is a column of five united filaments, bearing five hooded nectaries, each containing a narrow, incurved horn (Fig. 35, 2, 3, 4). These nectaries are alternate with the divisions of the corolla, as are the anthers also. Each of the two-celled anthers has a flat wing on either side, projecting at right angles to the column (Fig. 35, 5, 6). The wings of adjacent anthers lie closely together, leaving a narrow slit between, which is wider at the bottom than at the top. Just above this slit is a small shining black body (*corpuscula* or, less properly but more commonly, *gland*), which is cleft in the centre and tapers at top and bottom. This so-called gland is fastened by elastic threads to a pollen-mass on either side, in such a way that the pollen-masses of neighboring anthers are connected, while those belonging to the same anther are quite distinct (Fig. 35, 7, 8). The connective of each anther is continued into a membranaceous appendage, which clasps the disk in the centre of the flower.

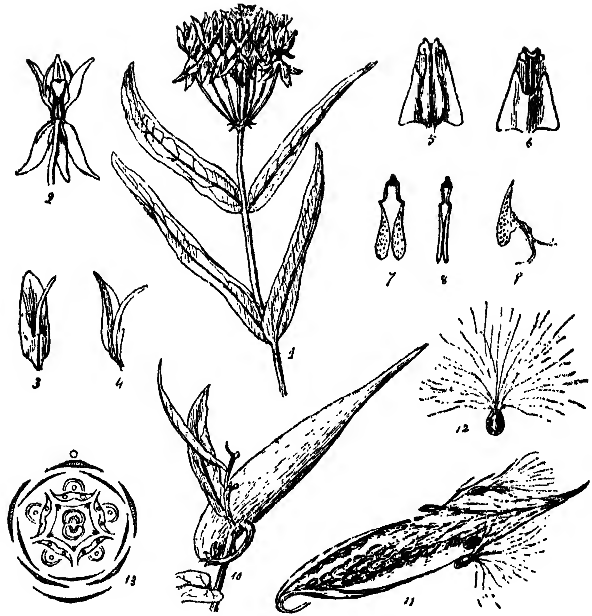

FIG. 35. — Butterfly-Weed. 1. Flowering branch. 2. Section of flower. 3, 4. Nectary. 5. Anther from without. 6. Anther from within. 7. Pollen-masses. 8. Pollen-masses after movement has taken place. 9. Pollen-mass sending out pollen-tubes. 10. Pod. 11. Pod splitting. 12. Seed. 13. Diagram.

The pistil is of two carpels with separate ovaries, containing many seeds, and short styles, stigmatic at the top, the stigmas being connected with the outside world only through the slits between the anthers. Above these stigmas is a five-lobed disk, over which the tips of the anthers clasp tightly. This disk is not really stigmatic and acts as a covering merely (*gynostegium*).

The fertilization is accomplished as follows. An insect searching for nectar alights on the flower and clasps the central column with his legs, while he explores a nectary with his proboscis. In so doing, he often gets his leg caught in a slit between the anthers, and in endeavoring to pull it out drags it up through the slit, and wedges some of the hairs on his leg into the cleft gland. This is accomplished by the hair being wedged in the split part of the gland, not through any stickiness. If he succeeds in extricating himself (and sometimes a small bee will find himself quite unable to get away, or will leave his leg behind him), he will bring with him two pollen-masses attached to the gland. A movement then takes place in the pollen-

masses, which are at first in the same plane (Fig. 35, 7), by which they are brought closely face to face (Fig. 35, 8). This movement takes place rather slowly, so that by the time the two masses of pollen are thus fitted together the insect has reached another flower. If the same movement is repeated, and the bee's leg is again pushed into a slit, a pollen-mass is often pushed in also, and torn away from the gland when the insect leaves the flower. Here they send out copious pollen-tubes to the stigmas within (Fig. 35, 9), and the flower is fertilized.

This is not accomplished without frequent fatalities among the insect visitors. I have often seen bees, flies, and even butterflies caught by our large Milkweed (*A. cornuti*), and forced to undergo a lingering death from starvation. Another mode of death is mentioned in the following extract: —

"On a single specimen I counted over one hundred pollen-masses attached to the claws and legs. When the claws are thus fettered the bee cannot climb upon the combs nor collect honey, and is soon expelled from the hive and

must die. The unfettered bees tumble them out with little ceremony."[1]

The fruit of all the Milkweeds is a follicle filled with numerous seeds (Fig. 35, 11), bearing each a beautiful tuft of down (Fig. 35, 12), which must aid them materially in their dissemination and help to render them so widely spread and so common. Often only one of the pair of follicles develop (Fig. 35, 10).

SPREADING DOGBANE (*Apocynum androsæmifolium*).[2]

An interesting family to compare with the Milkweeds is the Dogbane family (*Apocynaceæ*). The Spreading Dogbane flowers in June and July, and is quite common on the edges of thickets and along the roadsides.

It is an herb, growing about two feet high, with stems branching towards the top, and opposite, simple, entire leaves. The juice is milky. The flowers are small, in loose cymose clusters (Fig. 36, 1).

[1] American Naturalist, Vol. III, p. 109. See also Botanical Gazette, Vol. XII, pp. 207–216, 244–250. [2] Appendix, p. 368.

The calyx is small, with five lanceolate lobes. The corolla is bell-shaped, five-lobed, white, with rose-colored stripes alternating with the lobes, and a triangular appendage near the base, opposite the lobes. These little triangles fit into the openings between the anthers.

There are five stamens on the base of the corolla, with thick, short, hairy filaments, and arrow-shaped anthers which connive closely around the style (Fig. 36, 2, 4, 5). The tips of the anthers are membranaceous and meet at the apex, so as to cover the style completely (Fig. 36, 3). The anthers are two-celled and the barbs at the base curve outward, making the slits between wider at the bottom than at the top. Alternating with the filaments are nectar-glands, which may be the rudiments of an inner circle of stamens.

The pistil is of two carpels, with separate ovaries and a single style, which is thick, short, and two-lobed at the apex. The style is divided across by a membrane and all the pollen is contained in the upper part of the anthers, so that no pollen can reach the lower, stigmatic portion of the style without the aid of in-

Fig. 36. — Spreading Dogbane. 1. Flowering branch. 2. Flower with half the perianth cut away. 3. Vertical section of flower. 4, 5. Anther. 8. Branch with fruit. 9. Seed. 10. Diagram.

sects.[1] The approach to the stigma is through the slits between the anthers, as in the Milkweed. In the case of the Dogbane, the insect, while sucking the nectar from the gland which lies just below the slit, gets his tongue caught. The upper part of the style is glutinous, and looks like a stigmatic surface, but it is probable that the sticky substance there acts merely as a cement, with which the fly comes in contact in his struggles to escape, and by its aid carries away the light, granular pollen, which is afterwards deposited on the stigmatic surface of another flower. It is certain that flies and small bees are often caught, and we shall find their remains in many blossoms.

The fruit is a follicle, and the seeds are furnished with a tuft of down (Fig. 36, 9), but, whether from failure to fertilize, or some other reason, the plant seldom sets seed.

Let us sum up the resemblances between this flower and the Milkweeds: the leaves are opposite, simple, and entire; the juice is milky; the anthers enclose the pistil, and are so placed that

[1] Torrey Bulletin, Vol. III, 46, 49, 53, 57.

the slits between adjacent anthers often detain insects, and cross-fertilization is carried out by means of this trap; the style is in two portions, of which the lower is the stigmatic portion, while the upper part is developed into a disk in the Milkweeds, and a glutinous, two-horned appendage in the Dogbane; the way to the stigma lies only through the slits between the anthers in both. Finally, the fruit of both is a pair of follicles, and the seeds have a tuft of down to aid their dissemination.

Both these families, *Asclepiadaceæ* and *Apocynaceæ*, are distinguished, in the group of regular gamopetalous plants, by their simple, entire leaves, milky juice, and two ovaries, becoming follicles in fruit. In the former family the filaments are united and the pollen coheres in masses; in the latter the filaments are distinct and the pollen is granular.

Water-Lily (*Nymphæa odorata*).[1]

In June our Water-Lily begins to blossom.

The stem of this plant is a rootstock, immersed

[1] Appendix, p. 364.

in the mud at the bottom of the pond in which the flowers float. This stem is not like the ordinary stems of dicotyledons, but resembles the monocotyledons in structure.[1]

The large, heart-shaped, entire leaves float on the surface of the water. They have triangular stipules close to the rootstock.

We do not like to cut the exquisite flower for

[1] The stems of our Water-Lilies consist of submerged rhizomata or rootstocks. The true Lilies are monocotyledonous plants, and their stems are distinctly endogenous; the strengthening tissues, the bast-fibres, being scattered throughout in an apparently irregular manner. The stems of most dicotyledonous plants are, on the contrary, exogenous, having their bast-fibres arranged in a cylinder, within which lies the wood as a shaft, and around the whole the outer bark is wrapped. In herbaceous dicotyledons the wood exists generally in a soft and sometimes almost unrecognizable state, but as a rule there is a distinction to be made out between the bast and the wood, and they are not arranged together in fibres scattered throughout the mass of the stem.

In the Water-Lilies, however, which are dicotyledonous plants, the stem is only obscurely exogenous; it resembles rather that of some monocotyledons, and might easily be mistaken for endogenous structure. The stems are perennial both in the sweet-scented or eastern species and in the western sweet-scented Nymphæa tuberosa. — Wild Flowers of America. George L. Goodale. Illustrated by Isaac Sprague. Boston, S. E. Cassino, 1882, p. 161.

a vertical section, but we must in order to find out anything about its structure.

The sepals, petals, and stamens are arranged spirally, and are adnate to the ovary. There is no absolute distinction between sepals and petals, or between petals and stamens. The four outer perianth-leaves are green and shining without, and white and delicate within. The next in order are tinged without with green, and become pure white, and gradually smaller, as we approach the centre of the flower. The innermost petals are contracted, tinged with yellow, and some of them bear anther-cells at the tips. Finally, around the stigma are the perfect stamens, with slender filaments, and adnate anthers.

The pistil has a many-celled ovary, with the seeds on the walls, except on the edges of the carpels. This is an exception to the general rule, for we have seen in all the flowers we have studied that the ovules are borne on the edges of the carpels. There is no style; on the top of the pistil there is a little round globular head from which radiate the stigmas, covering the top of the ovary, and ending in sterile tips which

curve upwards. These are golden yellow like the stamens.

The fruit is a capsule, maturing under water, and the seeds are enclosed in a covering called an *aril*.

The gradual change of the petals into stamens is very instructive, and is cited in the following chapter as a good illustration of the origin of the stamens from modified leaves.

The family to which the Water-Lily belongs (*Nymphæaceæ*) has generally hypogynous flowers and will be found in that group. It is distinguished by containing aquatic plants with the ovules borne on the back or sides of the carpels, not, as in most plants, on the edges of the carpels. The leaves are peltate or cordate, and floating. The yellow Cow-Lily (*Nuphar advena*) is another common member of the family.

Sweet-Vernal Grass (*Anthoxanthum odoratum*).[1]

In June the grasses begin to flower abundantly, and we must not neglect this important family, although it is a somewhat difficult study.

[1] Appendix, p. 365.

One of the easiest of our early blossoming grasses to analyze is the Sweet-Vernal Grass, which gives such a delicious odor to the hay.

It is a rather delicate grass, about a foot high. The roots are fibrous, and the plant is perennial. The stem is hollow with closed joints, and is called a *culm*. The bases of the culms produce shoots, which run underground, and throw up erect stems, making the plant densely tufted, the usual habit of grasses which make turf. The leaves are long, narrow, and parallel veined, and are arranged alternately on the opposite sides of the stem. They sheathe the stem for some distance, so that the leaf is in two distinct portions, the *sheath* and the *blade*. Where these join there is a membranaceous appendage, the *ligule*.

At the end of the flowering stem is the flower-cluster, which is a contracted spike-like panicle in the Anthoxanthum. The flower-cluster is composed of small separate clusters, called *spikelets* (Fig. 37, *D*, 2).

In examining a grass, after we have described

the general vegetative characters and the whole inflorescence, we must always isolate a spikelet and examine it under a lens. We shall find that the Anthoxanthum spikelet is composed of six alternating bracts (*glumes*), making a crowded, two-ranked cluster, with two stamens and a pistil within. The lower glume is keeled, the next about twice as large, of firmer texture and nerved; the two next are two-lobed, hairy, and keeled, with the keel produced into a long bristle called an *awn* (Fig. 37, *D*, 2). The fifth bract is transparent and thin, tightly enclosing the sixth, which is smaller. These last two enclose the flower, which consists of two distinct stamens, and a pistil with a one-celled, one-seeded ovary, and two feathery stigmas. The two bracts which enclose the flower are named respectively the *flowering glume* and the *palet*. Formerly they were both called palets, the outer and the inner palet. In most grasses this palet differs from the flowering glume in shape, nerving, and texture, and is not inserted on the main axis of the spikelet, but on the lateral branch which holds the flower. It is, therefore, proper to call it by

a special name, and, by analogy, it is called the palet in the Anthoxanthum also.[1]

The Sweet-Vernal Grass, then, consists of one-flowered spikelets with six glumes (or five glumes and a palet), and a single, apparently terminal, flower, with two stamens and a one-celled ovary. We have here a very simple flower.[2] There is another sweet grass, Hierochloe, used, also, by the Indians for weaving baskets, where each bract, corresponding to the inner empty glumes of the Anthoxanthum, has a flower in its axil, making the spikelet three-flowered.

Another common early-blossoming grass is the Meadow-Foxtail (*Alopecurus pratensis*).

[1] The view of Bentham, Hackel, and other authorities is that the palet is a bract (or two bracts united) on the lateral branch that holds the flower. The former view was that the palet represents the outer circle of the perianth, while the scales at the base of the stamens (*lodicules*), when present, are the remains of an inner circle. See reference on p. 274.

[2] Darwin says in a letter to Hooker in 1855, four years before the publication of the Origin of Species. "I have just made out my first grass, hurrah! hurrah! I must confess that fortune favors the bold, for, as good luck would have it, it was the easy *Anthoxanthum odoratum:* nevertheless it is a great discovery; I never expected to make out a grass in my life, so hurrah! It has done my stomach surprising good." — Life and Letters of Charles Darwin. By Francis Darwin. Vol. I, p. 418.

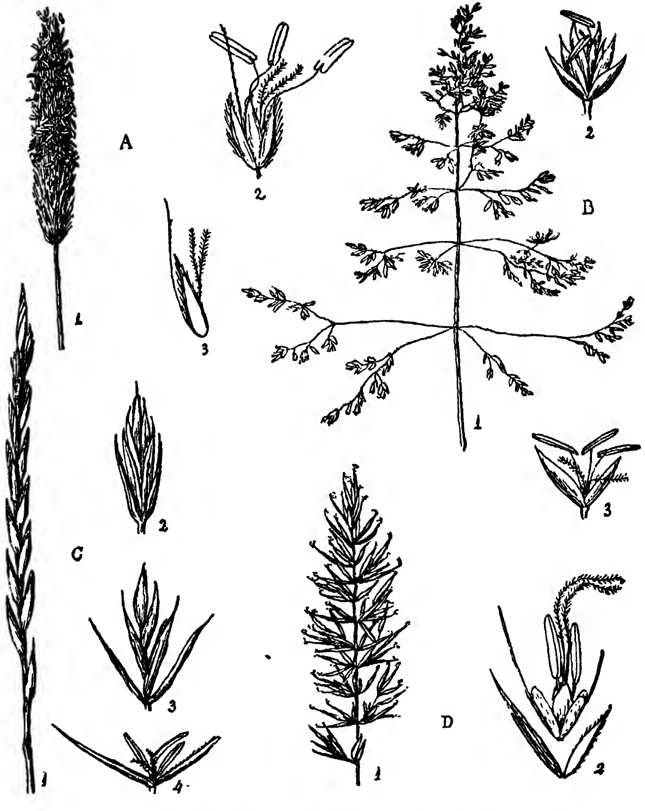

Fig. 37. — A. Meadow-Foxtail Grass (*Alopecurus pratensis*): 1. Flowering spike; 2. Spikelet; 3. Single flower. B. Kentucky Blue-Grass (*Poa pratensis*): 1. Flowering panicle; 2. Spikelet; 3. Single flower. C. Couch-Grass (*Agropyrum repens*): 1. Flowering

This has a close, contracted, spike-like cluster of flowers (Fig. 37, *A*, 1). A single spikelet (*A*, 2) consists of three glumes. The inner flowering glume has a long, twisted awn on the back, and encloses the flower. There are three stamens (the usual number in *Gramineæ*), and an ovary with feathery stigmas, similar to that of Anthoxanthum. There is no inner bract opposite the flowering glume, and, therefore, the flower is described as having no palet (*A*, 3). This grass is *proterogynous*, the stigmas withering before the stamens discharge. It has a creeping rootstock, and leafy culms, and is a good grass for meadows.

A grass with many flowers in a spikelet may be seen in our common Kentucky Blue-Grass (*Poa pratensis*). A spikelet consists of a number of flowers crowded on the rhachis. Each flower is enclosed in a flowering glume and a palet, and has three stamens. The two glumes at the base of the spikelet are empty and act the part of an involucre (Fig. 37, *B*, 2). Each flower has a tuft of cobwebby hairs at the base, which is not indicated in the illustration. The

plant has underground runners and a short ligule.

Another common grass, with many-flowered spikelets, is the troublesome Couch-Grass (*Agropyrum repens*). This grass is coarse and its running rootstocks are difficult to completely destroy. The spikelets are two-ranked on the terminal spike (Fig. 37, *C*, 1), compressed and sessile, with the sides against the axis. Each flower is enclosed in a narrow, keeled, rigid, flowering glume, tapering into a point or an awn, and a flattened, hairy palet, adhering to the grain. There are three stamens. The two lower glumes of the spikelet are empty, green, and nerved. The grass is very variable and very widely spread.

It is of course impossible in this volume to give more than the merest hints for the study of *Gramineæ*. The teacher will find an excellent account of the whole family in The True Grasses, by Hackel,[1] and references to other

[1] The True Grasses. By Eduard Hackel. Translated from Die Naturlichen Planzenfamilien, by F. Lamson-Scribner. New York, Henry Holt & Co., 1890.

literature on the subject will be found in that work.

The grasses are wind-fertilized, and the perianth has been wholly dispensed with, unless certain scales (*lodicules*), which are found in many genera at the bases of the stamens, represent the floral envelopes. They have two-ranked leaves, hollow stems, and flowers in the axils of glumes consisting of two or three stamens and a pistil with a one-celled ovary, and a single suspended ovule. The two stigmas are feathery (*plumose*).

The family *Gramineæ* will be found in the glumaceous division of the monocotyledons, where we find also the Sedge family (*Cyperaceæ*). The sedges have three-ranked leaves, solid triangular stems, and flowers in the axils of glumes, without perianth, the ovary one-celled with a single erect ovule.

The Morphology of the Flower.

We have already given our definition of a flower: "A flower is a simple branch modified for the production of seed." We are justified in

assuming, even as a result of our course, short as it is, that the object of the flower is to produce seed, for we have seen that the color and fragrance, shape and structure, of each part has a direct relation to the fertilization of the flower or the dissemination of the seed.

If the flower is a branch, it follows that its organs must be modified leaves. We have seen what varied forms leaves may assume, in the cotyledons of the Pea, the bud-scales of the Beech, and the tendrils of the Bean, so that it will not surprise us to find that the organs of the flower are also modified leaves.[1]

In many of the flowers we have studied the calyx is not unlike a whorl of leaves. The sepals of the Trillium, in texture, color, and veining, are almost exactly like its leaves, and the petals are like the sepals in shape and veining, although they differ in texture and color. In the Barberry flower, the bracts pass into the sepals in such a manner that it is rather an arbitrary line that we draw between them.

Externally, the sepals of the Water-Lily are

[1] Reader in Botany. XVI.

not very unlike leaves, green, shining, and parallel veined. We have just seen that we cannot absolutely distinguish sepals from petals, nor petals from stamens in this flower.

The outer petals are tinged with green, and are thicker and coarser in texture than the inner petals; and, as they draw near the centre of the flower, they become more and more contracted and are tinged with yellow. Some of them have rudimentary pollen-sacs at their tips. Through these gradations we come to a perfect stamen, where the anther evidently corresponds to the tip of the leaf, and the filament to its lower portion. Here we have the clearest evidence that these organs are all modified leaves. As in the Lilac bud (Part I, p. 68), we saw that there was no place where we could call one organ a leaf and the next organ a scale, so here there is no dividing line between sepal and stamen.

It is very common for stamens to revert to petals. This is the reason of the loss of the essential organs in double flowers, as, for instance, in the greenhouse Rose. We can see examples

of it every day in our Hollyhocks, Geraniums, Poppies, and many other flowers.

The leaf-like character of the carpels is generally not so clear. We have some excellent examples in the Columbine and Caltha pods, which, in early summer, will be ready for study. After splitting, they show their leaf-origin very plainly. The petal-like stigmas of Iris also show the similarity of origin of the carpels and the perianth.

Another case in point is the reversion of the carpels to leaves, which we noticed in the Double Cherry, where the reversion takes place normally. Monstrosities of this sort may occur in any flower-organs, and if the pupils are advised to seek them, some interesting specimens will probably be obtained. The study of monstrosities is called *teratology*.

A much better understanding of the flower is gained if we regard it from this point of view. Indeed, we may say that the whole of modern Botany relating to the Flowering Plants is the proof of its truth, for we assume it as the foundation of all our study.[1] The sepals, petals,

[1] Reader in Botany. XVI.

stamens, and carpels are modified leaves. In the staminal leaf the pollen is developed in interior cells, on either side of the connective, which answers to the midrib of the leaf. Anthers are, therefore, normally two-lobed. In the carpellary leaves the ovules, in most cases, are developed on the margins. We may compare them with the buds on the leaves of Begonia and Bryophyllum. The pollen and the ovules may be regarded as male and female plants, which by their union produce a new individual combining the qualities of both its parents.

The conception of the flower as a branch, modified for the production of seed, teaches us that the showy floral envelopes are accessory parts. The flower, if we use the term in its widest sense, consists of a simple axis, bearing stamens, or carpels, or both. But when the leaves close to these essential organs are modified in color and structure, and have a relation to fertilization and dissemination, they are considered as a part of the flower, and are called the perianth.

The most primitive plants are simple. The

group to which the Willow belongs, containing amentaceous plants, represents an early geological type. The Willow has two kinds of flowers, one consisting of two stamens, the other of two carpels. Each of these flowers is subtended by a bract, and this is all that we found, except a small gland at the base of the essential organs. Other members of this group, as the Birch and Elm, have a calyx surrounding each group of stamens. In the Elm, belonging to a group somewhat higher in the scale, the calyx consists of a little cup, delicately tinted with red.

Looking at the other great branch of the Flowering Plants, the monocotyledons, we see an extremely simple flower in the Arisæma. The staminate flowers consist of two-celled or four-celled anthers, in groups of two or three, and the pistil is syncarpous, forming a few-seeded pod or berry. These organs are on a densely flowered axis, without any trace of perianth. We can see a simple perianth in a plant belonging to the same family, the Skunk-Cabbage (*Symplocarpus*).

We have studied flowers with the parts free

and separate, like the Buttercup and Hepatica, which have bright-colored perianths, and flowers with the parts more combined, which are yet quite regular and simple in structure, like the Apple, and other members of the Rose family. Finally, we have seen the floral organs modified into such wonderful structures as the flowers of Milkweed and (among the monocotyledons) of Orchids. These are higher forms, developed in relation to the development of certain insects, in later geological times. But, in these cases, we can still trace the underlying structure of their remote ancestors, with simple and separate perianths. We made such a study in connection with the Cypripedium.

It would appear at first sight that we have abandoned the idea that the colors and fragrance of flowers are intended for the delight of man, and, indeed, we shall find the notion that they have any relation to human pleasure scouted in the books of the day, even by literary writers, who might be expected to take a wider view of the matter.

The fact that the colors of flowers have been

developed to attract insects does not explain why they are so adapted to delight our eyes. In a world where we perceive every part to be correlated with the rest, it is not reasonable to suppose that the gratitude and reverence that spring up so naturally in our minds at the sight of loveliness are the only isolated and meaningless facts in the universe.

I, for my part, believe that the study of any Natural Science should awaken reverence for the mysterious beauty of the world; and that the teacher who takes no account of this sentiment is throwing away one of the chief benefits of the study, without which, as it appears to me, it may even be positively hurtful to the forming character.

> "Flower in the crannied wall,
> I pluck you out of the crannies; —
> Hold you here, root and all, in my hand,
> Little flower — but if I could understand
> What you are, root and all, and all in all,
> I should know what God and man is."

It is this spirit that should inform our teaching, not the shallow pride of knowledge of a few dry facts.

APPENDIX.

The following schedule is not intended to be used at first by the pupils, who should rather begin with very simple descriptions of the plants studied. They should gradually make their descriptions fuller and fuller until they are acquainted with the terms necessary for filling out this schedule, and can undertake it without the discouragement that would be sure to ensue if so many new terms were given at once. When the student can fill out this schedule correctly he will be able to analyze the Flowering Plants without difficulty.

A vertical section is necessary to determine the union of the different circles of the flower (pp. 5, 6). To determine the number of cells in the ovary a cross section must be made (pp. 4, 5). A bud is required to examine the æstivation (p. 46).

It is seldom that the teacher can provide specimens with root, flower, and fruit for examination in the schoolroom; but the pupil should be made to understand that a thorough knowledge of every part of the plant is highly desirable, and should be gained as far as possible. In his field studies he should be taught to observe the plant in all its stages of growth. Moreover, the present schedule

being, after all, a rather dry view of the plant, akin to the lifeless herbarium specimen, the student should be encouraged to observe the habits of the living plant, to notice the insects that frequent it, its adaptations for bidden guests, its contrivances for protection from unwelcome visitors, its means of dissemination, its manner of growth, the soil which it prefers, and many other points relating to its life. All such observations may be added to the descriptions, and will be a preparation for real scientific usefulness and a key to a never-failing source of delight.

SCHEDULE FOR PLANT-DESCRIPTION.

NAME { SCIENTIFIC / COMMON.	Gray's Lessons, revised edition, 1889, 535–539.[1]
FAMILY OR ORDER[2]	Lessons, 529.
HABITAT AND TIME OF FLOWERING.[3]	Country, state, or town. Meadow, woods, roadsides.
PLANT[3]	Height in feet and inches, form (as herb, shrub, tree, vine), duration (as annual, biennial, perennial), 83–87. Outlines I, p. 42.
ROOT	Kind and shape, 65–82. Outlines I, pp. 39, 40.

[1] All the references are to this work, unless otherwise stated. The numbers refer to paragraphs.

[2] The terms are used synonymously by Gray. German authors use the term *Order* to signify groups of nearly related families.

[3] In the following schedules these characters are placed in a general account of the plant at the beginning of each description.

STEM	Structure (monocotyledonous or dicotyledonous type), habit (as erect, twining, creeping, etc.), kind (as scape, rootstock, tuber, etc.), surface (as smooth, rough, hairy), 88–117. Outlines I, pp. 103–105.
LEAVES	Position, arrangement, type (simple or compound), venation, shape, apex, base, margin, surface, texture, vernation, 121–164, 181–193. Outlines I, pp. 121–126.
PETIOLE	Form and length.
STIPULES	Form (describe as leaves), 174–180.
INFLORESCENCE AND BRACTS.	197–227. Outlines II, p. 205.
ÆSTIVATION DIAGRAMS.	273–280. Outlines II, p. 182.
FLOWER RECEPTACLE.	Plan (complete, perfect, regular, etc.), size, 323–327. Outlines II, p. 141.
PERIANTH (leaves)	Term used to describe the floral envelopes when the calyx and corolla are not clearly distinguishable. Describe union of leaves, number, color, form, and insertion (hypogynous, perigynous, epigynous).
CALYX (sepals)	Union of sepals, insertion, number, and form, 269–271. (Describe sepals as leaves.)
COROLLA (petals)	Union of petals, insertion, number, color, and form, 248–271. (Describe petals as leaves.)
STAMENS	Number, union, insertion, etc., 281–285. Outlines II, pp. 57–64.
FILAMENTS	Length, form, etc., 286.
ANTHERS	Form, insertion (basifixed, dorsifixed, adnate, innate), position (as introrse, extrorse, versatile), number of cells, and dehiscence, 287–299. Outlines II, pp. 59–64.

Pistil	Simple or compound, number and union of carpels, 300–316. Outlines II, pp. 81–86.
Ovary	Adnation (superior, inferior), form, number of cells, placentation, number and position of ovules, 306–312, 317–322.
Style	Number, length, form, etc., 302.
Stigma	Number, form, position, 302.
Fruit	Character (simple, multiple, aggregate), texture (dry, fleshy), kind (berry, drupe, capsule), 345–379. Outlines II, pp. 142–150.
Seeds	Number, form, number of cotyledons, presence or absence of endosperm (albumen), 380–392. Outlines II, p. 226.
Remarks	Any striking peculiarities of the plant, adaptations for cross-fertilization, or uses in commerce.

Almost all of the following descriptions have been made by the author from fresh specimens, and her work has been checked and supplemented by suggestions from Gray's Manual, Torrey's Flora of New York, and other systematic works. Most of the measurements have been taken from the two Flora above mentioned.

To make an accurate description, not of a single individual only, but of a whole species, is a matter of no small difficulty; and the author is quite aware that many characters which are here represented as constant must be extremely variable. She earnestly requests that any mistakes or omissions may be brought to her notice.

Note. — There are numerous Plant records published, in the form of books to hold descriptions and of blanks with printed headings. One of the simplest and best of these is by Edward T. Nelson, and is published by Allyn & Bacon, Boston. It consists of four-page blanks, with headings nearly as in the above schedule, and a prefatory leaflet containing a list of botanical terms and some directions for pressing, mounting, and collecting. The description is on the first page, and the specimen is to be mounted on the third page. The whole is enclosed in a portfolio, and the price is seventy-five cents, postpaid.

TULIPA GESNERIANA. Tulip.

Family LILIACEÆ.

An early bulbous perennial, cultivated for its showy flowers. Height, 1 foot. Spring. Native of the Levant.

ROOT	Of clustered fibres.
STEM	Monocotyledonous type, bulbous, erect, fleshy, smooth, generally two-leaved above the ground.
LEAVES	Alternate, simple, parallel-veined, ovate or oblong, apex acute, base clasping, entire, smooth, fleshy, clasping in the bud.
PETIOLE	None.
STIPULES	None.
INFLORESCENCE AND BRACTS.	Flower large, solitary, terminal, erect. Bracts like the leaves.
ÆSTIVATION.........	Imbricated. (See diagrams on pp. 3 and 5.)
FLOWER	Complete, regular, symmetrical.
RECEPTACLE	Flat.
PERIANTH (leaves)...	Leaves separate (*polyphyllous*), free, 6, ovate, apex retuse or rounded, the three inner (petals) smaller. Colors various.
CALYX (sepals)......	
COROLLA (petals)....	
STAMENS	6; distinct, hypogynous.
FILAMENTS	Short, awl-shaped.
ANTHERS	Basifixed, two-celled, dehiscence longitudinal.
PISTIL..............	Compound, 3 carpels, syncarpous.
OVARY	Superior, triangular, columnar, three-celled, central placenta, many ovules in two rows in each cell.
STYLE	None.
STIGMA	Three-parted, crested.

FRUIT ....A capsule, loculicidal.
SEEDS ....Many, monocotyledonous, albuminous.
REMARKS ....Kerner states that the nectar is contained in the bases of the filaments (1).

HYACINTHUS ORIENTALIS. Hyacinth.

Family LILIACEÆ.

An early bulbous perennial, cultivated for ornament.
Height, 1 foot. Spring. Native of the Levant.

ROOT ....Fibrous.
STEM ....Monocotyledonous type, not continued beyond the bulb.
LEAVES ....Radical, simple, parallel-veined, lanceolate, acute, entire, smooth, fleshy.
  PETIOLE ....None.
  STIPULES ....None.
INFLORESCENCE AND BRACTS......Flowers in a terminal raceme, on a thick, fleshy scape. Pedicels very short. Bracts small, lanceolate or awl-shaped, or none.
ÆSTIVATION.........Imbricated.
FLOWER ....Complete, regular, symmetrical.
  RECEPTACLE ....Flat.
PERIANTH (leaves)...Bell-shaped, contracted at the throat, free, six-lobed, divisions oblong, the inner narrower.
CALYX (sepals).......
COROLLA (petals)....
STAMENS ....6, distinct, on perianth.
  FILAMENTS .....Very short, broad, closing the throat of perianth.
  ANTHERS ....Dorsifixed, introrse, two-celled, dehiscence longitudinal.
PISTIL..............3 carpels, syncarpous.

Ovary ....Superior, three-celled, central placenta, many ovules, anatropous, horizontal.

Style ....Short. ridged.

Stigma ....Terminal, three-lobed or parted.

Fruit ....A capsule, triangular.

Seeds ....Few, monocotyledonous, albuminous.

Remarks ....Flowers very fragrant.

CROCUS VERNUS. Crocus.

Family Iridaceæ.

An early bulbous perennial, cultivated for ornament.
Height, 6 inches. Spring. Native of Europe.

Root ....A cluster of fibres.

Stem ....Monocotyledonous type, a corm.

Leaves ....Radical, simple, parallel-veined, lanceolate, fleshy, smooth, midrib white, margin revolute until after flowering.

Petiole ....None.

Stipules ....None.

Inflorescence and Bracts. ......Flowers terminal, and in the axils of the thin papery bracts which sheathe the whole season's growth. Each flower also sheathed by bracts.

Æstivation ....Imbricated.

Flower ....Complete, regular, symmetrical.

Perianth (leaves)...Trumpet-shaped, base of tube adnate to ovary, six-cleft, tube long and slender, partially underground, lobes ovate, obtuse.

Calyx (sepals)......

Corolla (petals)....

Stamens............3, distinct, adnate to perianth and opposite its outer divisions.

Filaments .....Short.

ANTHERS........Dorsifixed, oblong, extrorse, two-celled, dehiscence longitudinal.

PISTIL..............3 carpels, syncarpous.

OVARY.........Inferior, three-celled, placentation central, many ovules in two rows.

STYLE..........Long and slender.

STIGMA.........Three-parted, fringed, and petal-like.

FRUIT..............A three-valved capsule, appearing above the surface of the ground.

SEEDS..............Many, monocotyledonous, albuminous.

REMARKS...........Saffron is obtained from the stigma of another species, Crocus sativus.

GALANTHUS NIVALIS. Snowdrop.

Family AMARYLLIDACEÆ.

An early bulbous perennial, cultivated for ornament.
Height, 6 to 9 inches. Spring. Native of Great Britain.

ROOT..............Fibrous.

STEM...............Monocotyledonous type, not prolonged above the bulb.

LEAVES.............Radical, simple, parallel-veined, linear, obtuse, entire, smooth, fleshy, a single pair, enclosed in a scaly sheath.

PETIOLE........None.

STIPULES.......None.

INFLORESCENCE AND BRACTS......Flowers terminal, solitary, nodding from a cleft bract.

ÆSTIVATION.........Outer leaves imbricated, inner convolute. (See diagram on p. 12.)

FLOWER............Complete, regular, symmetrical.

RECEPTACLE....Enclosing the ovary.

PERIANTH (leaves)...6 separate leaves on an epigynous disk, 3 outer leaves, white, ovate, concave, 3 inner

half as long, striped within and spotted without with green, notched at apex.

CALYX (sepals) .....

COROLLA (petals)....

STAMENS............6. distinct, on an epigynous disk.

FILAMENTS .....Very short.

ANTHERS ....Long, pointed, ending in a horn-like, reflexed process, basifixed, two-celled, dehiscing by two slits at the apex, sometimes splitting throughout the whole length.

PISTIL ....3 carpels, syncarpous.

OVARY ....Inferior, three-celled, placentation central, ovules many.

STYLE ....Simple, slender, pointed.

STIGMA ... .Terminal.

FRUIT ....A capsule.

SEEDS ....Monocotyledonous, albuminous.

REMARKS ....The nectar is contained in the green spots on the petals. The pollen falls out of the slits of the anthers when an insect shakes them by touching the horn-like processes, dusts the bee visiting the flower for nectar or pollen, and is carried to the next flower.

TROPÆOLUM MAJUS. Garden-Nasturtium.

Family GERANIACEÆ.

An annual herb, with pungent juice, climbing by its leaf-stalks, cultivated for ornament.

Height, 6 feet. Flowering in Summer. Native of South America.

ROOT ....Of fleshy fibres.

STEM ....Climbing, weak, round, smooth.

LEAVES ....Alternate, simple, palmate-veined, shield-shaped, margin slightly wavy, smooth

above, minutely downy beneath, thin, vernation open.

PETIOLE ....Long, round, smooth, twining.

STIPULES ....None, or minute.

INFLORESCENCE AND BRACTS......Flowers solitary in the axils. Bracts none.

ÆSTIVATION.........Imbricated. (See diagram on p. 2[illegible], Fig. 5.)

FLOWER ... .Complete, regular.

RECEPTACLE ....Flat.

PERIANTH (leaves)...

CALYX (sepals)......Gamosepalous, free, five-cleft, three upper sepals prolonged backward into a long descending spur, colored.

COROLLA (petals)....Polypetalous, 5 petals, adnate to calyx, the three lower petals at the base, the two upper higher up, three lower with claws, fringed, two upper wedge-obovate.

STAMENS ....8, distinct, adnate to receptacle.

FILAMENTS. ....Short, unequal, awl-shaped.

ANTHERS ....Erect, basifixed, two-celled, dehiscence longitudinal.

PISTIL ....3 carpels, syncarpous.

OVARY ....Superior, deeply three-lobed around the base of the style, one ovule in each cell, pendulous.

STYLE ....Three-lobed.

STIGMAS ....3, terminating the branches of the style.

FRUIT ....Splitting into three closed, one-seeded, ribbed carpels.

SEEDS ....Generally three, dicotyledonous, exalbuminous.

REMARKS ....The stamens mature one at a time, and in a definite order, 7, 2, 4, 8, 5, 3, 6, 1. In some flowers the numbers go from right to left, in others from left to right.

PELARGONIUM ZONALE. House-Geranium.

Family GERANIACEÆ.

A shrubby perennial, cultivated in house and garden. Native of the Cape of Good Hope.

ROOT ....Fibrous.

STEM ....Exogenous, woody at base, erect, fleshy, downy.

LEAVES.............Alternate and opposite, simple, palmate-veined, kidney-shaped, margin wavy, crenate, downy, thick.

PETIOLE ....Round, hairy.

STIPULES ....Adnate to stem, becoming scaly.

INFLORESCENCE AND BRACTS......Flowers in terminal cymes, united into a single thick compound cluster, becoming apparently lateral by the stronger growth of the adjacent leaf-bud. Clusters surrounded by scaly bracts.

ÆSTIVATION ....Calyx imbricated, corolla convolute.

FLOWER ....Complete, slightly irregular, symmetrical.

RECEPTACLE ....Prolonged into a column, around which the carpels cohere.

PERIANTH (leaves)...

CALYX (sepals) .....Polysepalous, free, sepals 5, lanceolate, the two upper slightly larger and adnate to the pedicel below, forming a concealed spur.

COROLLA (petals)....Polypetalous, hypogynous, petals 5, rounded, wedge-shaped at base, two upper with short white claws.

STAMENS ....10, distinct, hypogynous. Stamens with anthers usually only 7.

FILAMENTS......Monadelphous.

ANTHERS ....Red, dorsifixed, introrse, dehiscence longitudinal.

PISTIL ....5 carpels, syncarpous.
OVARY ....Superior, carpels one-ovuled.
STYLES ....5, united around the receptacular column.
STIGMAS ....5, stigmatic on the inner surface of the styles.
FRUIT ....Carpels splitting elastically from the central column, hairy within, spirally twisted in the middle, with a straight beak.
SEEDS ....5, dicotyledonous, exalbuminous.
REMARKS ....Seeds partially self-planting.

FUCHSIA COCCINEA.

Family ONAGRACEÆ.

A showy cultivated perennial, with opposite leaves, and hanging red and purple flowers.

Native of South America.

ROOT ....Fibrous.
STEM ....Exogenous, woody, climbing.
LEAVES ....Opposite, simple, pinnate-veined, lance-ovate, apex acute, base heart-shaped or obtuse, serrate with blunt teeth, smooth.
PETIOLE ....Channelled, red.
STIPULES ....Minute.
INFLORESCENCE AND BRACTS. ......Flowers solitary, nodding from the axils. Peduncles long and slender. Bracts none.
ÆSTIVATION ....Calyx valvate, corolla convolute.
FLOWER ....Complete, regular, symmetrical.
PERIANTH (leaves)...
CALYX (sepals)......Gamosepalous, adnate to ovary, five-cleft, lobes lanceolate, as long as the straight round tube, which is much prolonged above the ovary, generally light-colored.

COROLLA (petals) ....Polypetalous, inserted on the calyx, petals 4, red or purple, wedge-obovate or round, shorter than calyx lobes.

STAMENS............8, distinct, exserted, on the calyx.

FILAMENTS......Unequal, slender, red.

ANTHERS ....Adnate, introrse, two-celled, dehiscence longitudinal.

PISTIL ....4 carpels, syncarpous.

OVARY ... .Inferior, four-celled, central placenta ; ovules many in three rows.

STYLE ....Long, exserted, slender.

STIGMA ....Terminal, club-shaped, four-lobed.

FRUIT ....A berry.

SEEDS ....Many, dicotyledonous, exalbuminous.

REMARKS ....Nectar in the throat of the tube.

ABUTILON STRIATUM. Indian Mallow.

Family MALVACEÆ.

A shrub, cultivated for ornament, with alternate heart-shaped leaves, and axillary, bell-shaped, pendent flowers, the typical flowers reddish orange, veined with darker lines.

Native of Brazil.

ROOT ....Fibrous.

STEM ....Woody, erect, branched.

LEAVES ....Alternate, simple, pinnate-veined, ovate, apex acuminate or three-lobed, base heart-shaped, crenate, thin, smooth.

PETIOLE ....Downy, short, round.

STIPULES ....Lateral, on the stem.

INFLORESCENCE AND BRACTS......Flowers solitary, pendent from the axils.

ÆSTIVATION.........Calyx valvate, corolla convolute.

FLOWER ....Complete, regular, symmetrical.

PERIANTH (leaves)...
CALYX (sepals)......Gamosepalous, free, five-cleft, inflated, a little contracted at the throat, lobes pointed, three-nerved, downy.
COROLLA (petals)....Polypetalous, hypogynous, 5, round with claws, veiny.
STAMENS ....Many, united, joined to base of petals.
FILAMENTS......Monadelphous, separating into a cluster of anther-bearing filaments.
ANTHERS ....One-celled, basifixed, heart-shaped, dehiscing round the margin.
PISTIL..............10 carpels, syncarpous.
OVARY..........Superior, ten-celled, with a single row of seeds in each cell, placentation central.
STYLE..........Ten-parted, slender.
STIGMAS........Terminal.
FRUIT..............A capsule, separating into two to nine-seeded carpels.
SEEDS..............Many, dicotyledonous, scantily albuminous.
REMARKS...........Nectar at the base of the calyx tube.

RHODODENDRON INDICUM. Azalea.

Family ERICACEÆ.

A shrub, cultivated for ornament, with alternate leaves crowded on the ends of the shoots, and terminal flowers with scaly bracts. Native of China.

ROOT ....Fibrous.
STEM ....Woody, erect, bristly with rusty hairs.
LEAVES ....Alternate, simple, pinnate and netted veined, oblanceolate, obtuse, tipped with a short, blunt point, entire, hairy, revolute in the bud.

PETIOLE	None.
STIPULES	None.
INFLORESCENCE AND BRACTS.	Flowers in terminal, scaly-bracted clusters. Peduncle short, covered with sticky, glandular hairs.
ÆSTIVATION.........	Calyx and corolla imbricated, corolla ribbed.
FLOWER	Complete, slightly irregular, symmetrical.
PERIANTH (leaves)...	
CALYX (sepals)......	Polysepalous, free, sepals 5, lanceolate, glandular hairy.
COROLLA (petals)....	Gamopetalous, hypogynous, slightly irregular, trumpet-shaped, five-cleft, lobes oval, obtuse or retuse, variously colored.
STAMENS	10, distinct, hypogynous.
FILAMENTS	Slender, long, turning upward.
ANTHER	Dorsifixed, introrse, two-celled, dehiscing from a pore at the apex of each cell.
PISTIL	5 carpels, syncarpous.
OVARY..........	Glandular hairy, five-celled, central placentation, placentæ projecting back into the cells; ovules many.
STYLE	Exserted, at first declined.
STIGMA	Capitate.
FRUIT	
SEEDS	
REMARKS	

BEGONIA SEMPERFLORENS.

Family BEGONIACEÆ.

A cultivated perennial, with oblique, shining leaves, and white or rose-colored flowers of two kinds on the same plant.

Native of Brazil.

ROOT	Fibrous.

STEM	Round, smooth, fleshy.
LEAVES	Alternate, simple, pinnate-veined, base oblique, apex pointed, entire, shining, smooth, with a bloom beneath.
PETIOLE	Thick, smooth, channelled.
STIPULES	Thin, adnate to stem.
INFLORESCENCE AND BRACTS.	Terminal and axillary cymose clusters on long peduncles. Staminate flowers terminal and regular, pistillate flowers lateral and oblique. Bracts small, scaly.
ÆSTIVATION	Staminate flowers valvate, pistillate flowers imbricated. (See diagram on p. 54, Fig. 6.)
FLOWER	Incomplete, monœcious, staminate flowers first developing.
PERIANTH (leaves)...	Staminate flowers of four separate leaves, in two circles, the outer broadly ovate, the inner smaller, pistillate flowers of five or six separate leaves, adnate to ovary.
CALYX (sepals)......	
COROLLA (petals)....	
STAMENS	Many, distinct, in a head.
FILAMENTS......	Short, unequal.
ANTHERS	Innate, connective very large, two-celled, dehiscence longitudinal.
PISTIL	3 carpels, syncarpous.
OVARY..........	Inferior, three-lobed, the lobes unequally winged, three-celled, central placentation, the placentæ projecting far back into the cells; ovules many, small.
STYLES	3, two-parted.
STIGMAS	Horseshoe shaped, spiral.
FRUIT	A capsule.
SEEDS	Many, dicotyledonous, exalbuminous.
REMARKS	

HEPATICA TRILOBA.

Family RANUNCULACEÆ.

A perennial herb, common, leaves radical, the delicate blue, pinkish, or white flowers appearing before the leaves in the centre of the cluster of dry leaves of the previous season.

Height, 6 inches. Flowering in April, in open woods.

ROOT	Of coarse fibres.
STEM	A short, underground rootstock.
LEAVES	Radical, simple, palmate and netted veined, kidney-shaped, palmately three-lobed, entire, silky beneath, involute in the bud.
PETIOLE	Covered with silky hairs.
STIPULES	None.
INFLORESCENCE AND BRACTS.	Flowers solitary on hairy scapes, in the axils of underground bracts which sheathe the whole season's growth. Involucre of three bracts, close to the flower, imitating a calyx.
ÆSTIVATION	Imbricated.
FLOWER	Incomplete, regular.
RECEPTACLE	Conical.
PERIANTH (leaves)	
CALYX (sepals)	Polysepalous, free, sepals 6 or 7, petal-like, oblong.
COROLLA (petals)	None.
STAMENS	Many, distinct, on receptacle.
FILAMENTS	Unequal, the outer shorter.
ANTHERS	Innate, two-celled, dehiscence longitudinal.
PISTIL	Apocarpous, carpels many, in a head.
OVARY	Hairy, acuminate, an akene ; ovule suspended, anatropous.
STYLE	None.
STIGMA	Sessile, pointed.

Fruit ....A head of akenes.
Seeds ....Suspended, dicotyledonous, albuminous.
Remarks ....The flower has no nectar.

ANEMONE NEMOROSA. Wood-Anemone. Wind-Flower.

Family Ranunculaceæ.

A very delicate and pretty perennial herb, open woods, common, flower nodding on a peduncle from a three-leaved involucre. Height, 3 to 8 inches. Flowering in early Spring.

Root ....Fibrous.
Stem ....A filiform underground rootstock, 2 to 3 inches long.
Leaves ....Radical, palmately three-parted, leaflets 3, wedge-oval, toothed and cut, sometimes five-parted, stem leaves similar, forming a three-leaved involucre.
  Petiole ....Round, hairy.
  Stipules ....None.
Inflorescence and Bracts. ......Flowers solitary, terminal; peduncle about as long as the involucre.
Æstivation.........Imbricated. (See diagram on p. 68, Fig. 8.)
Flower ....Incomplete, perfect, regular, 1 inch broad.
Perianth (leaves)...
Calyx (sepals)......Polysepalous, free, sepals 5 or 6, oval, white, often tinged with pink.
Corolla (petals)....None.
Stamens ....Many, distinct, hypogynous.
  Filaments .....Unequal, the outer shorter.
  Anthers ....Innate, two-celled, dehiscence longitudinal.
Pistil ....Apocarpous, carpels many, in a head.
  Ovary ....An akene, with a hooked beak; ovule suspended, anatropous.

STYLE ....None.
STIGMA ....Bent, pointed.
FRUIT ....A head of akenes.
SEEDS ....Suspended, dicotyledonous, albuminous.
REMARKS ....The flower has no nectar.

CALTHA PALUSTRIS. Marsh-Marigold. Cowslip.

Family RANUNCULACEÆ.

A perennial herb, with showy yellow flowers, swamps, common northward.

Height, 6 to 10 inches. Spring.

ROOT ....Of coarse, clustered fibres.
STEM ....Erect and branching, hollow, ribbed, and smooth.
LEAVES ....Radical leaves heart-shaped, toothed, 2 to 4 inches broad. Stem leaves alternate, simple, palmately-veined, heart-shaped or kidney-shaped, crenate, smooth.
PETIOLE ....Long in the radical leaves, short in the stem leaves.
STIPULES ....Adnate to stem, thin, papery.
INFLORESCENCE AND BRACTS......Flowers in the upper axils, somewhat corymbose.
FLOWER ....Incomplete, perfect, regular, 1 inch or more across.
PERIANTH (leaves)...
CALYX (sepals)......Polysepalous, free, sepals 5 to 9, broadly oval or ovate, yellow.
COROLLA (petals)....None.
STAMENS ....Many, distinct, free.
FILAMENTS .....Unequal, the outer shorter.
ANTHERS ....Innate, two-celled, dehiscence longitudinal.

PISTIL ....Apocarpous, carpels 5 to 10 in a head.
OVARY..........One-celled, many seeded; ovules horizontal, anatropous.
STYLE ....None.
STIGMA ....Beaked.
FRUIT ....A head of follicles, spreading widely open when ripe, sometimes resembling a flower after the discharge of the seeds.
SEEDS ....Oblong, purple, dicotyledonous, albuminous.
REMARKS ....Sometimes used for "greens" in spring.

THALICTRUM DIOICUM. Meadow-Rue.

Family RANUNCULACEÆ.

A perennial herb, with decompound leaves, and diœcious-panicles of purplish or greenish flowers, rocky woods, common. Height, 1 to 2 feet. April, May.

ROOT ....Clustered woody fibres.
STEM ....Slender, branched, smooth.
LEAVES ....Alternate, ternately decompound, leaflets drooping, three-lobed, crenate, rounded, smooth, glaucous.
PETIOLE ... .Dilated at base, sheathing, both divisions and leaflets stalked.
STIPULES ....None.
INFLORESCENCE AND BRACTS......Flowers in terminal panicles, diœcious.
ÆSTIVATION.........Imbricated.
FLOWER ....Incomplete, regular.
RECEPTACLE ....
PERIANTH (leaves)...
CALYX (sepals)......Polysepalous, free, 4 or 5 sepals, oval, caducous.

COROLLA (petals) .... None.
STAMENS .... Many, distinct, free.
FILAMENTS ..... Exserted, capillary, filiform, weak.
ANTHERS .... Nodding, linear, mucronate, two-celled, dehiscence longitudinal.
PISTIL .... 6 to 10 carpels, apocarpous.
OVARY.......... One-celled, one-ovuled; ovules anatropous.
STYLE ... . Longer than the ovary.
STIGMA .... Long, linear, one-sided.
FRUIT .... An akene, ovoid, ribbed, pointed.
SEEDS .... 1, dicotyledonous, albuminous.
REMARKS .... A wind-fertilized flower, without nectar or bright color.

SANGUINARIA CANADENSIS. Blood-Root.

Family PAPAVERACEÆ.

A perennial herb, with radical leaves and pure white flowers on naked scapes, from a thick rootstock filled with orange-red juice, rich woods, common.

Height, 3 to 8 inches. Early Spring.

ROOT .... Fibrous.
STEM .... An underground, creeping rootstock, thick and fleshy, filled with orange-red juice.
LEAVES .... Radical, simple, palmate-veined, kidney-shaped, deeply seven-lobed, lobes dentate, dark green above, whitish beneath, involute and inclosing the flower in the bud.
PETIOLE .... Thick and fleshy, with orange-red juice.
STIPULES .... None.
INFLORESCENCE AND BRACTS. ...... Flowers generally solitary, enclosed with the leaf in sheathing bracts, which are almost entirely beneath the ground.

FLOWER ....Complete, regular, symmetrical, 1 to 1½ inches wide.

PERIANTH (leaves)...

CALYX (sepals)... ..Polysepalous, free, sepals 2, ovate, fugacious.

COROLLA (petals)....Polypetalous, free, petals 8 to 12, oblong, white, in two circles, the inner petals a little smaller.

STAMENS ....Many, distinct, free.

FILAMENTS .....Unequal, the outer shorter.

ANTHERS........Linear, innate, two-celled, dehiscence longitudinal.

PISTIL ....2 carpels, syncarpous.

OVARY ....One-celled, 2 parietal placentæ; ovules many, anatropous.

STYLE ....Very short.

STIGMAS ....2, united, thick.

FRUIT ....An oblong pod, two-valved, the valves splitting away from the persistent placentæ.

SEEDS ....Thick, with a crested rhaphe, dicotyledonous, albuminous.

REMARKS ....The plant bleeds when broken. The root is used as an emetic.

CLAYTONIA VIRGINICA. Spring Beauty.

Family PORTULACACEÆ.

A delicate, low perennial herb, flowers bell shaped, nodding, veined with rose-pink, moist and low grounds, common westward and southward.

Height, 6 to 10 inches. Spring.

ROOT ....Fibrous.

STEM ....Simple, from a small deep tuber.

LEAVES ....One pair of opposite leaves, pinnate-veined, 2 to 4 inches long, simple, linear-lanceolate, entire, thick, smooth.

Petiole	None, or lower leaves contracted into a petiole.
Stipules	None.
Inflorescence and Bracts.	Flowers in a loose raceme. Bracts small.
Æstivation	Imbricated.
Flower	Complete, regular, symmetrical.
Perianth (leaves)	
Calyx (sepals)	Polysepalous, free, sepals 2, broadly ovate.
Corolla (petals)	Polypetalous, free, petals 5, oval, obtuse or acute, with claws, pink, with rose-colored veining, a yellow spot at base.
Stamens	5, distinct, opposite the petals.
Filaments	Flat, joined to base of petals.
Anthers	Dorsifixed, extrorse, two-celled, dehiscence longitudinal.
Pistil	3 carpels, syncarpous.
Ovary	One-celled, ovules rising from the base, stalked, campylotropous.
Style	Three-cleft.
Stigma	Stigmatic on the inside of the divisions.
Fruit	A pod, three-valved, 3 to 6 seeded.
Seeds	Black, shining, dicotyledonous, albuminous.
Remarks	Stamens maturing first, and turning back against the petals when the branches of the style open (proterandrous).

TRIENTALIS AMERICANA. Star-Flower.

Family Primulaceæ.

A perennial herb, with a simple, erect stem bearing a whorl of leaves at the top, and small, white flowers, solitary or several from the leaf-axils, moist woods.

Height, 9 inches. May.

Root .... Fibrous.
Stem .... A slender, creeping rootstock, throwing up simple, erect branches.
Leaves .... Lower leaves small, scale-like, scattered; upper leaves crowded or in a whorl at the summit, pinnate-veined, lanceolate, tapering at both ends, finely serrate, thin, veiny.
  Petiole .... None.
  Stipules .... None.
Inflorescence and Bracts. ...... Flowers solitary or few from the whorl of leaves, peduncle very slender.
Æstivation .... Imbricated.
Flower .... Complete, regular, symmetrical.
  Receptacle .... Flat.
Perianth (leaves) ...
Calyx (sepals) ...... Gamosepalous, 6 to 8 parted, divisions pointed.
Corolla (petals) .... Gamopetalous, hypogynous, 6 to 8 parted, flat, spreading, ovate with acuminate tips.
Stamens .... 6 to 8, united, on corolla, and opposite its lobes.
  Filaments ...... Smooth, slender, monadelphous at base.
  Anthers .... Oblong, two-celled, dehiscence longitudinal, revolute after flowering.
Pistil .... Syncarpous.
  Ovary .... Superior, one-celled, free central placenta; ovules amphitropous.
  Style .... 1, slender.
  Stigma .... 1, terminal.
Fruit .... A capsule, globose, dehiscing by valves.
Seeds .... Few, dark, rough, dicotyledonous, albuminous.
Remarks ....

EPIGÆA REPENS. Trailing Arbutus. Mayflower.

Family ERICACEÆ.

A prostrate, evergreen, perennial plant, with alternate leaves and fragrant rose-colored and white flowers in terminal clusters, sandy woods.

April, May.

ROOT	Fibrous, at the joints of the stem.
STEM	Prostrate or trailing, running underground, somewhat woody, rusty-hairy.
LEAVES	Alternate, simple, pinnate-veined, ovate, base heart-shaped, evergreen, thick, and leathery.
PETIOLE	Slender.
STIPULES	None.
INFLORESCENCE AND BRACTS.	Flowers in terminal clusters, each flower surrounded with an involucre; peduncle short and hairy; buds formed during the previous summer, scaly.
ÆSTIVATION	Imbricated. (See diagrams on p. 88, Fig. 10).
FLOWER	Complete, regular, symmetrical.
RECEPTACLE	Flat.
PERIANTH (leaves)	
CALYX (sepals)	Polysepalous, free, sepals 5, ovate.
COROLLA (petals)	Gamopetalous, free, pink and white, salver-shaped, border five-lobed, tube thickly clothed within with white hairs.
STAMENS	10, distinct, slightly united to base of corolla, flowers dimorphous as to the stamens, the short stamens having generally no anthers.
FILAMENTS	Of two lengths in different flowers.
ANTHERS	Adnate, introrse, two-celled, dehiscence longitudinal.
PISTIL	5 carpels, syncarpous.

OVARY ....Glandular-hairy, five-lobed, five-celled, placentation central; ovules many, anatropous.
STYLE ....Forming a five-lobed ring or collar around the stigmas.
STIGMAS ....5, of two lengths; longer in the flowers with short stamens.
FRUIT ....A fleshy, five-angled capsule, loculicidal.
SEEDS ....Many, dicotyledonous, albuminous.
REMARKS ....The flower seldom sets seed. Fertile flowers are always those with long stigmas.

VIOLA CUCULLATA. Common Blue Violet.

Family VIOLACEÆ.

A low perennial herb, with simple radical leaves, and blue flowers on naked scapes, very common.
Flowering in Spring.

ROOT ....Fibrous.
STEM ....A rootstock, thickly covered with fleshy teeth.
LEAVES ....Radical, simple, palmately-veined, heart-shaped, crenate, smooth.
PETIOLE ....Channelled.
STIPULES ....Lance-shaped, hairy.
INFLORESCENCE AND BRACTS......Flowers solitary, scape smooth, with two small bracts.
ÆSTIVATION ....Imbricated. (See diagram on p. 92, Fig. 11.)
FLOWER ....Complete, irregular, symmetrical.
RECEPTACLE ....Flattish.
PERIANTH (leaves)...
CALYX (sepals)......Polysepalous, free, sepals 5, lance-ovate, auricled at the base.
COROLLA (petals)....Polypetalous, free, petals 5, the lower spurred

at the base, spur short and thick, lateral petals bearded.

Stamens .... 5, distinct, but conniving over the pistil, free.

Filaments .....Continued beyond the anthers, lower stamens with a nectar-secreting appendage projecting into the spur.

Anthers ....Adnate, introrse, two-celled, dehiscence longitudinal.

Pistil ....3 carpels, syncarpous.

Ovary ....One-celled, 3 placentæ, covering the face of the wall; ovules many, anatropous.

Style ....One.

Stigma ....Club-shaped, turned on one side and slightly beaked.

Fruit ....A capsule, loculicidal, splitting elastically, throwing the seeds.

Seeds ....Many, dicotyledonous, albuminous.

Remarks ....Bearing also closed (cleistogamous) flowers near or beneath the ground, which are more fertile than the ordinary ones.

HOUSTONIA CÆRULEA. Innocence, Bluets, Quaker Lady.

Family Rubiaceæ.

A very delicate biennial herb, with small, opposite, spatulate leaves, and bluish terminal flowers, meadows.

Height, 3 to 6 inches. Spring and Summer.

Root ....Fibrous.

Stem ....Delicate, slender, erect, smooth.

Leaves.............Opposite, simple, spatulate-oblong, acute, entire, sessile, smooth.

Petiole ....None.

STIPULES	Minute, connecting the leaves.
INFLORESCENCE AND BRACTS.	Flowers cymosely-clustered or solitary; peduncle very slender.
ÆSTIVATION	Valvate. (See diagrams, p. 98, Fig. 12.)
FLOWER	Complete, regular, symmetrical, 4 to 5 lines long.
RECEPTACLE	Flat.
PERIANTH (leaves)...	
CALYX (sepals)	Gamosepalous, adnate to ovary, four-cleft, divisions lance-linear.
COROLLA (petals)....	Gamopetalous, on calyx, salver-form, four-lobed, white or bluish, with a yellow eye.
STAMENS............	4, distinct, on corolla.
FILAMENTS......	None.
ANTHERS	Two-celled, introrse, dehiscence longitudinal, inserted in some flowers low down, and in others on the throat of the corolla.
PISTIL	2 carpels, syncarpous.
OVARY	Two-celled, central placenta; ovules 4 to 20 in each cell.
STYLE	1, dimorphous, one form long, the other short.
STIGMAS	2.
FRUIT	A capsule, broader than long, half-free from calyx, loculicidal at the top.
SEEDS	Roundish, pitted, dicotyledonous, albuminous.
REMARKS	The flower is dimorphous, the short and long styles being fertilized by the stamens of corresponding length.

ERYTHRONIUM AMERICANUM. Dog-Tooth Violet.

Family LILIACEÆ.

A bulbous perennial plant, with two shining, mottled, radical leaves, and solitary yellow flowers on naked scapes, low copses, common.

Height, 6 to 10 inches. Spring.

ROOT ....Fibrous.

STEM .... A deep, underground, scaly corm, throwing out underground branches.

LEAVES ....2, radical, sheathing the base of the one-flowered scape, 5 to 8 inches long, 1 to 1½ wide, lance-oval, entire, smooth, shining, mottled with brown.

- PETIOLE ....Leaf tapering into petiole.
- STIPULES ....None.

INFLORESCENCE AND BRACTS. ......Flower solitary, nodding, on a naked, smooth peduncle.

ÆSTIVATION ....Imbricated. (See diagram on p. 100, Fig. 13.)

FLOWER ....Complete, regular, symmetrical.

- RECEPTACLE ....Flat.

PERIANTH (leaves)...6 leaves, distinct, linear, light yellow, spotted near the base.

CALYX (sepals)......Linear, recurved.

COROLLA (petals)....Broadly lanceolate, with a callous tooth on each side of the base.

STAMENS ....6, distinct, free, half the length of perianth.

- FILAMENTS .....Flat, awl-shaped.
- ANTHERS ....Innate, two-celled, yellow or reddish brown, longitudinal dehiscence.

PISTIL ....3 carpels, syncarpous.

- OVARY ....Three-celled, placentation central; ovules in two rows, anatropous.

Style	Club-shaped, three-lobed.
Stigmas	3, often united into one.
Fruit	A capsule, loculicidal.
Seeds	Numerous, with a loose appendage at the apex, monocotyledonous, albuminous.
Remarks	Do the different colors of the anthers denote fertile and sterile flowers?

SALIX PETIOLARIS. Petioled Willow.

Family Salicaceæ.

A shrub, growing in wet places, with lanceolate, serrate leaves, and catkins appearing before the leaves from a glossy-black scale. Height, 4 to 10 feet. April.

Stem	Exogenous, branching freely from near the ground.
Leaves	Alternate, simple, lanceolate, serrate, grayish beneath.
Petiole	Short.
Stipules	Small, toothed, deciduous.
Inflorescence and Bracts.	Diœcious, the sterile flowers in ovoid catkins, the fertile in cylindrical catkins, one flower under each scale, the middle flowers first expanding; scales black, acute, silky-hairy. Several small bracts at the base of each catkin.
Æstivation	No floral envelopes.
Flower	Imperfect, a small gland at the base of each flower.
Receptacle ...	
Perianth (leaves)..	
Calyx (sepals)......	None.
Corolla (petals) ...	None.

STAMENS............2, distinct.
FILAMENTS......Elongating, slender, round.
ANTHERS ....Dorsifixed, extrorse, two-celled, longitudinal dehiscence.
PISTIL..............2 carpels, syncarpous.
OVARY ....Stalked, silky-hairy, tapering, one-celled, 2 parietal placentæ; ovules many, anatropous.
STYLE ....Short.
STIGMA ....Two-parted.
FRUIT ....A pod, loculicidal.
SEEDS ....Exalbuminous, dicotyledonous, furnished with silky down.
REMARKS ....Very attractive to bees from the fragrance and abundance of nectar.

QUERCUS RUBRA.

Family CUPULIFERÆ.

A large forest tree, with reddish wood, dark furrowed bark, and bristly, pointed, pinnatifid leaves; flowers monœcious, appearing with the leaves; common.

Height, 50 to 80 feet. May.

STEM................Exogenous, trunk and branches stout, the branches nearly at right angles with the trunk.
LEAVES..............Alternate, simple, pinnately veined, pinnatifid, sinuses acute, lobes bristle-pointed, apex acuminate, downy when young, becoming smooth.
PETIOLE ....Slender, rather short.
STIPULES ....Deciduous.

INFLORESCENCE AND BRACTS.	Monœcious; sterile flowers in lateral, drooping catkins, fertile flowers solitary or clustered in the axils of the leaves of the season, sterile flowers naked, the fertile sessile surrounded by an appressed involucre (acorn-cup).
ÆSTIVATION	Open.
FLOWER	Imperfect.
RECEPTACLE	
PERIANTH (leaves)	
CALYX (sepals)	Sterile flowers gamosepalous, of 3 or more little scaly lobes, fertile flowers without floral envelopes.
COROLLA (petals)	None.
STAMENS	4 to 6, distinct, free.
FILAMENTS	None.
ANTHERS	Sessile, basifixed, erect, two-celled, dehiscence longitudinal.
PISTIL	3 carpels, syncarpous.
OVARY	Three-celled, three-ovuled.
STYLE	Spreading, three-lobed.
STIGMA	The lobes stigmatic within.
FRUIT	An acorn, maturing the second year, cup shallow, saucer-shaped, sessile or slightly stalked.
SEED	One, exalbuminous, dicotyledonous.

ULMUS AMERICANA. American Elm.

Family URTICACEÆ.

A large, deciduous tree, with alternate, simple leaves, and small, perfect flowers appearing before the leaves in April.

ROOT	Fibrous.

STEM	Exogenous, a tall, straight trunk, branching into a fine spreading head.
LEAVES	Alternate, simple, pinnate-veined, ovate, acuminate at apex, unequal at base, coarsely serrate, smooth above, hairy beneath.
PETIOLE	Short.
STIPULES	Deciduous.
INFLORESCENCE AND BRACTS.	Flowers in clusters from axillary buds, on slender drooping pedicels, with a few bracts in the centre of the cluster.
ÆSTIVATION.........	Open.
FLOWER	Perfect, incomplete.
RECEPTACLE	
PERIANTH (leaves)...	
CALYX (sepals)......	Gamosepalous, a small oblique 7 to 9 cleft cup, edged with red, flattened laterally.
COROLLA (petals)....	None.
STAMENS	7 to 10, distinct, exserted on calyx.
FILAMENTS	Round, delicate, white.
ANTHERS	Two-celled, extrorse, dorsifixed, dehiscence longitudinal.
PISTIL	2 carpels, syncarpous.
OVARY	One-celled or sometimes two-celled, hairy, flattened, one-ovuled; ovule suspended.
STYLE	2, short.
STIGMA	Stigmatic within.
FRUIT	A samara, oval, flat, hairy, notched.
SEED	Exalbuminous, dicotyledonous.
REMARKS	The fruit matures early, and falls while the leaves are expanding.

ACER PLATANOIDES. Norway Maple.

Family SAPINDACEÆ.

A deciduous tree, cultivated for ornament, with large, bright green, rather thin leaves, and cymose clusters of greenish flowers, the flowers appearing before the leaves, and continuing to develop till the leaves are well grown.

May. Native of Europe.

ROOT	Woody, fibrous.
STEM	Exogenous, erect.
LEAVES	Opposite, simple, palmately five-cleft, the divisions incised with acuminate tips, heart-shaped at base, thin, smooth, and bright green.
STIPULES	None.
PETIOLE	Round, smooth.
INFLORESCENCE AND BRACTS.	Flowers in terminal, mixed clusters, a tiny linear bract at the base of each primary and secondary pedicel.
ÆSTIVATION	Calyx valvate, the inner edges turned backward (reduplicate), corolla imbricated. (See diagrams, p. 110, Fig. 15.)
FLOWER	Complete, regular, of two forms.
RECEPTACLE	With a fleshy disk.
PERIANTH (leaves)	
CALYX (sepals)	Gamosepalous, adnate to a fleshy, perigynous disk, deeply five-cleft, lobes oblong, obtuse.
COROLLA (petals)	Polypetalous, inserted on the disk at its base, 8 petals, spatulate, green.
STAMENS	8, sunk in the disk, distinct.
FILAMENTS	Short in the fertile, long in the sterile flowers.
ANTHERS	Two-celled, introrse, adnate, dehiscence longitudinal.

PISTIL ....Syncarpous, 2 carpels, free, but sunk in the centre of the disk, rudimentary in the flowers with long stamens.

OVARY ....Two-lobed, two-celled, 2 ovules in each cell, winged on the back of each cell.

STYLE ....Deeply two-cleft.

STIGMA ....Stigmatic on the inner side of the divisions of the style.

FRUIT ....A pair of samaras united by their inner faces, one-seeded.

SEEDS ....Exalbuminous, embryo with long, thin crumpled cotyledons.

REMARKS ....The short stamens do not dehisce, so that the flowers are really of separate sexes.

ÆSCULUS HIPPOCASTANUM. Horsechestnut.

Family SAPINDACEÆ.

A very large, spreading, deciduous tree, planted for ornament, with compound palmate leaves, and showy, pyramidal clusters of flowers.

May. Native of Asia.

STEM ....Exogenous, woody, branching so as to make the tree round-topped and dome-like in form.

LEAVES ....Opposite, palmately-compound, leaflets usually 7, wedge-obovate, apex acuminate, pinnate-veined, the veins running into teeth, serrate, leaves very large.

STIPULES ....None.

PETIOLE ....Thick, horseshoe-shaped at base.

INFLORESCENCE AND BRACTS......Flowers in a large dense cluster of mixed inflorescence, the primary branches inde-

terminate, the secondary with terminal flowers first developing, and the subsequent flowers lateral, giving the appearance of a raceme. Bracts none.

ÆSTIVATION.........Calyx and corolla imbricated. (See diagram on p. 120, Fig. 16.)

FLOWER............Complete, irregular, of two forms.

RECEPTACLE....Flat.

PERIANTH (leaves)...

CALYX (sepals)......Gamosepalous, adnate to a hypogynous, nectar-secreting disk, five-lobed, lobes roundish, unequal.

COROLLA (petals)....Polypetalous, adnate to disk, petals 4 or 5, woolly, with channelled claws, auricled at each side where the roundish blade joins the claw, the auricles pressed against the stamens, white, with yellow spots becoming crimson.

STAMENS...........Usually 7, distinct, at first declined.

FILAMENTS.....Unequal, lengthening as the anthers mature, joined to disk.

ANTHERS.......Adnate, introrse, dehiscence longitudinal. Pollen red.

PISTIL..............Generally imperfect in the upper flowers of the spike, consisting of an abortive ovary, and a short, pink-tipped style. In some of the lower flowers the style is long, and develops before the stamens.

OVARY.........Covered with glandular hairs, three-celled, 2 ovules in each cell.

STYLE..........In fertile flowers, long, curved upwards.

STIGMA.........Minute, terminal.

FRUIT..............A capsule, covered with sharp bristles, three-valved.

SEEDS..............1 to 3, large, brown, shining, cotyledons thick, fleshy, caulicle fitting into a little pocket in the shell.

REMARKS..........The change of color appears to be independent of fertilization, but is utilized by the bees as a guide, the red flowers, rifled of their nectar, remaining unvisited.

PINUS RIGIDA. Pitch Pine.

Family CONIFERÆ.

An evergreen tree, with dark green needles and prickly cones, sandy soil, common.

Height, 40 to 50 feet. May, June.

ROOT ....Woody.

STEM...............Wood without ducts, hard, resinous, bark dark-colored, very rough.

LEAVES.............Of two kinds, the primary leaves thin and scale-like, secondary leaves in their axils, in clusters of 3, needle-shaped, evergreen, sharp-pointed, in a short sheath of scales.

PETIOLE ....None.

STIPULES ....None.

INFLORESCENCE AND BRACTS.....Sterile flowers catkin-like, in clusters at the base of the shoot of the season; fertile flowers lateral on the new shoot.

ÆSTIVATION.........Floral envelopes none, carpellary scales imbricated.

FLOWER............Incomplete, monœcious.

RECEPTACLE ....

PERIANTH (leaves)...None.

CALYX (sepals)......

COROLLA (petals)....

STAMENS............Many, spirally arranged on the axis.
    FILAMENTS......Connective scale-like.
    ANTHERS........Pollen-sacs 2, on the under side of the scale-like connective, opening lengthwise.
PISTIL..............Carpels, many, open.
    OVARY ....None; ovules naked, a pair on each scale, orthotropous.
    STYLE ....None.
    STIGMA ....None.
FRUIT ....A cone formed of small outer scales (carpels[1]), and large rigid inner scales (placentæ[1]); the latter are recurved and bristle-pointed.
SEEDS ....2, nut-like, sunk in the placental scale and carrying away a part of the lining as a wing, polycotyledonous, albuminous.
REMARKS ....The homology of this group is much disputed, and some botanists doubt the advisability of trying to compare it at all with the flowering plants. The view adopted in this description may be found in Gœbel's Outlines (see note on p. 130). Each cluster of stamens and ovules is regarded as a single flower.

PYRUS MALUS. Apple.

Family ROSACEÆ.

A deciduous tree, cultivated for its fruit.
May. Native of Europe.

ROOT...............Fibrous, woody.

[1] The outer scales are regarded as bracts, and the inner scales as carpels, by Dr. Gray and others.

Stem	Exogenous, branching.
Leaves	Alternate, simple, pinnate-veined, broadly oval, apex acute, base heart-shaped, serrate, downy beneath, vernation involute.
Petiole	Short, channelled.
Stipules	Joined to petiole, small, linear or oblanceolate, deciduous.
Inflorescence and Bracts.	Flowers from mixed buds, in terminal, cymose clusters, surrounded by the leaves. Bracts awl-shaped.
Æstivation	Calyx and corolla imbricated. (See diagrams, p. 134.)
Flower	Complete, regular, symmetrical, large and showy.
Receptacle	Developed into a disk, lining the calyx tube.
Perianth (leaves)	
Calyx (sepals)	Gamosepalous, adnate to ovary, five-lobed, lobes lanceolate, downy.
Corolla (petals)	Polypetalous, perigynous on calyx, 5 petals, round with claws, white tinged with rose.
Stamens	Many, distinct, perigynous.
Filaments	Unequal.
Anthers	Dorsifixed, introrse, two-celled, dehiscence longitudinal.
Pistil	5 carpels, syncarpous.
Ovary	Inferior, five-celled, central placenta, 2 ovules in each cell.
Style	Five-cleft.
Stigmas	Terminal, oblique.
Fruit	A pome, crowned by the persistent calyx lobes, sunken at both ends.
Seeds	2 in each cell, dicotyledonous, exalbuminous.
Remarks	

PRUNUS CERASUS. Cherry.

Family Rosaceæ.

A deciduous tree, cultivated for its fruit.
April, May. Europe.

Root .... Perennial, fibrous, woody.
Stem .... Exogenous, erect.
Leaves .... Alternate, simple, pinnate-veined, oval, apex acuminate, serrate, smooth, vernation conduplicate.
  Petiole .... Short.
  Stipules .... Adnate to base of stem, lanceolate, toothed.
Inflorescence and Bracts. ...... Flowers and leaves in separate buds, the flowers 1, 2, or 3 from a single bud, but the buds grouped so as to make large clusters of flowers, appearing with the leaves.
Æstivation .... Imbricated. (See diagram, p. 134, Fig. 18.)
Flower .... Complete, regular, symmetrical.
  Receptacle .... Flat.
Perianth (leaves) ...
Calyx (sepals) ...... Gamosepalous, free, five-lobed, lobes reflexed, ovate.
Corolla (petals) .... Polypetalous, on calyx, petals 5, round, with claws, notched, white.
Stamens .... Many, distinct, on calyx.
  Filaments ...... Unequal.
  Anthers .... Dorsifixed, introrse, two-celled, dehiscence longitudinal.
Pistil .... Simple.
  Ovary .... One-celled, two-ovuled.
  Style .... Single.
  Stigma .... Terminal.
Fruit .... Drupe, fleshy and edible.

SEED .... 1, containing a bitter principle resembling prussic acid, dicotyledonous, exalbuminous.

REMARKS ....

FRAGARIA VIRGINIANA. Strawberry.

Family ROSACEÆ.

A low herb, with runners, with white flowers in cymose clusters, and a juicy red fruit, wild and cultivated.
Flowering in Spring.

ROOT .... Fibrous.

STEM .... Underground, bearing runners.

LEAVES .... Radical, palmately-compound, leaflets 3, wedge-obovate, coarsely toothed towards the apex.

PETIOLE .... Long, channelled.

STIPULES .... Adherent to base of petiole, thin, lanceolate.

INFLORESCENCE AND BRACTS. ...... Flowers in cymes, on hairy scapes. Bracts leaf-like.

FLOWER .... Complete, regular.

RECEPTACLE .... Conical.

ÆSTIVATION .... Calyx valvate, corolla imbricated. (See diagram, p. 136, Fig. 19.)

PERIANTH (leaves) ...

CALYX (sepals) ...... Gamosepalous, free, deeply five-cleft, with 5 bracts between the lobes, lobes lanceolate.

COROLLA (petals) .... Polypetalous on calyx, 5 petals, round with claws.

STAMENS .... Many, distinct, on calyx.

FILAMENTS ...... Unequal.

ANTHERS .... Two-celled, innate, dehiscence longitudinal.

PISTIL .... Apocarpous, carpels many, in a head on enlarged receptacle.

Ovary..........One-celled.
Style..........Short, lateral.
Stigma.........Terminal.
Fruit..............Accessory, on enlarged receptacle becoming juicy and holding the indehiscent dry carpels, which resemble seeds.
Seeds...............Many, small.
Remarks...........There is an endless number of varieties of the cultivated fruit.

RANUNCULUS BULBOSUS. Buttercup.

Family Ranunculaceæ.

A common weed, with compound leaves and solitary flowers terminating the branches, fields.
Height, 1 foot. Spring and early Summer.

Root...............Of fleshy fibres.
Stem...............Bulbous, simple or branching diffusely from the base, hairy.
Leaves............Radical and cauline, alternate, ternately compound, leaflets pinnately incised and lobed, hairy.
Petiole........Deeply channelled, very short, flat and clasping, radical leaves with sessile, lateral divisions, the terminal long-stalked.
Stipules.......None.
Inflorescence and Bracts......Flowers solitary, terminal, bracts leaf-like, peduncles furrowed.
Æstivation.........Imbricated. (See diagrams, p. 154, Fig. 20.)
Flower............Complete, regular, symmetrical.
Receptacle....Conical.
Perianth (leaves)...
(sepals)......Polysepalous, free, 5 sepals, ovate, reflexed, deciduous, valvate.

COROLLA (petals)....Polypetalous, on receptacle, 5 petals, sometimes 6 or 7, wedge-obovate, with a little scale at the base, yellow, shining, imbricated.

STAMENS............Many, distinct, on receptacle.

FILAMENTS......Unequal.

ANTHERS ....Innate, two-celled, dehiscence longitudinal.

PISTIL..............Compound, apocarpous, carpels many in a head.

OVARY..........One-celled, one-ovuled, ascending, anatropous.

STIGMA ....Beaked.

FRUIT ....A head of akenes flattened.

SEEDS..............Erect, dicotyledonous, albuminous.

REMARKS ....Müller says that the nectar is secreted in the little scale at the base of the petals. I have never been able to find any nectar.

AQUILEGIA CANADENSIS. Wild Columbine.

Family RANUNCULACEÆ.

A graceful, perennial plant, with compound leaves and nodding, spurred, red and yellow flowers, in rocky places.
Height, 12 to 18 inches. Spring and early Summer.

ROOT...............Spindle-shaped.

STEM...............Loosely branching from the base.

LEAVES.............Radical and cauline, palmately-compound, 2 to 3 ternate, leaflets wedge-obovate, incised, obtuse, glaucous beneath.

PETIOLE ....Delicate, round, smooth.

STIPULES........Small, adnate to petiole.

INFLORESCENCE AND BRACTS......Flowers solitary, nodding on slender pedicels, terminal and axillary from three divided bracts.

ÆSTIVATION.........Calyx valvate, corolla imbricated. (See diagrams, p. 156, Fig. 21.)
FLOWER............Complete, regular.
RECEPTACLE....Flat.
PERIANTH (leaves)...
CALYX (sepals)......Polysepalous, free, 5 sepals, ovate, colored like the petals.
COROLLA (petals)....Polypetalous, hypogynous, 5 petals, hollow, prolonged backwards into a straight nectariferous spur, red, yellow within, spurs callous at the tips.
STAMENS............Many, distinct, on receptacle.
FILAMENTS......Unequal, the outer recurved, the inner reduced to flat scales.
ANTHERS.......Innate, two-celled, dehiscence longitudinal.
PISTILS.............5, apocarpous.
OVARY.........Hairy-celled, many-ovuled; ovules anatropous.
STYLE..........Long, tapering, slender.
STIGMA.........Terminal.
FRUIT..............A pod, erect.
SEEDS..............Black, shining, dicotyledonous, albuminous.
REMARKS...........

CORYDALIS GLAUCA.

Family FUMARIACEÆ.

A delicate, smooth biennial, pale, with compound dissected leaves, and racemes or panicles of rose-colored flowers tipped with yellow; rocky places, lasting sparingly through the summer.

Height, 1 to 2 feet. May.

ROOT...............A tap-root, biennial.
STEM...............Erect, pale, smooth.
VES.............Alternate, pinnately-compound, the leaflets

	incised, the divisions linear or oval, acute, smooth, gradually diminishing above to small leafy bracts
PETIOLE	Smooth, flat.
STIPULES	None.
INFLORESCENCE AND BRACTS......	Flowers in terminal racemes, the racemes panicled, slightly nodding. Bracts small, entire or incised.
ÆSTIVATION.........	Calyx valvate, corolla with petals in pairs.
FLOWER	Complete, irregular, symmetrical.
RECEPTACLE	Flat.
PERIANTH (leaves)...	
CALYX (sepals)......	Polysepalous, free, very small, ovate, acuminate, pink, 2 sepals.
COROLLA (petals)....	Petals slightly united, hypogynous, 4 petals, horizontal, upper petal produced backwards into a short rounded spur, the tip reflexed, yellow; lower petal boat-shaped, enclosing the pistil, yellow-tipped; two lateral petals united to upper, spoon-shaped, with thick, crested tips forming a hood over the anthers and stigma.
STAMENS............	6, joined to corolla.
FILAMENTS......	United, diadelphous, flat.
ANTHERS	Basifixed, introrse, middle anthers two-celled, lateral one-celled, dehiscence longitudinal.
PISTIL	2 carpels, syncarpous.
OVARY..........	Superior, linear, one-celled, 2 parietal placentæ; ovules many.
STYLE	Short, curved upward.
STIGMA	Two-lobed, terminal.
FRUIT	A pod, erect, long, and linear.
SEEDS	Shining, crested, dicotyledonous, albuminous.
REMARKS	

ARALIA NUDICAULIS. Wild Sarsaparilla.

Family ARALIACEÆ.

A perennial herb, with thick, aromatic rootstocks, a single three-parted leaf, and a terminal scape, bearing several umbels of greenish white flowers; moist woods.

Height, 1 foot. May, June.

ROOT .... Fibrous.
STEM .... A long, thick, woody, aromatic rootstock.
LEAVES .... 1 radical leaf, three-parted, divisions pinnate, leaflets 5, ovate lanceolate, serrate, downy.
  PETIOLE .... Long, swollen at the base, smooth.
  STIPULES .... None.
INFLORESCENCE AND BRACTS ...... Flowers in a compound umbel, with tiny scaly bracts.
ÆSTIVATION .... Valvate.
FLOWER .... Complete, regular, symmetrical.
  RECEPTACLE .... Flat.
PERIANTH (leaves) ...
CALYX (sepals) ...... Gamosepalous, adnate to ovary, lobes minute, pointed.
COROLLA (petals) .... Polypetalous, epigynous, 5 petals, ovate, white, reflexed.
STAMENS .... 5, distinct, epigynous.
  FILAMENTS ...... Inflexed at the apex.
  ANTHERS ...... Dorsifixed, extrorse, two-celled, dehiscence longitudinal.
PISTIL .... 5 carpels, syncarpous.
  OVARY .... Five-celled, placentation central; 1 ovule suspended in each cell.
  STYLES .... 5.
  STIGMAS .... Terminal.
FRUIT .... A berry-like drupe, dark purple.

SEEDS ....1 in each cell, dicotyledonous, albuminous.
REMARKS ....The roots are used as a substitute for sarsaparilla.

POLYGALA PAUCIFOLIA. Fringed Polygala.

Family POLYGALACEÆ.

A low perennial herb, with alternate simple leaves, the lower reduced to scales, and 1 to 3 short, peduncled, rose-purple flowers, equalling the leaves; dry woods.

Height, 6 to 9 inches. May.

ROOT ....Delicate fibres.
STEM ....Running underground, throwing up erect branches.
LEAVES ....Alternate, simple, crowded near the top of the stem, margin fringed, smooth, lower surface shining, lower leaves reduced to small, oval, entire scales.
PETIOLE ....Leaves contracted into a short petiole.
STIPULES ....None.
INFLORESCENCE AND BRACTS......Flowers 1 to 3, terminating the stem, peduncled.
ÆSTIVATION ....Imbricated.
FLOWER ....Complete, irregular, 9 lines long.
RECEPTACLE ....Flat.
PERIANTH (leaves)...
CALYX (sepals)......Polysepalous, free, persistent, 5 sepals, upper sepal boat-shaped, lateral sepals large, oval, spreading, rose-purple, two lower sepals lanceolate, small and greenish.
COROLLA (petals)....Gamopetalous, free, 3 petals, united into a lip, three-lobed, fringe-crested at the tip.
STAMENS.............6, diadelphous, united to petal.

FILAMENTS......	Flat.
ANTHERS	One-celled, opening by chinks at the top of the cell.
PISTIL	2 carpels, syncarpous.
OVARY	Superior, flattened, 2 cells; ovules 1 in each cell, pendulous, anatropous.
STYLE	Single, undivided, long, curved upward.
STIGMA	Terminal, flat.
FRUIT	A pod, flattened, margined, rounded, notched at the apex.
SEEDS	2, dicotyledonous, albuminous, caruncle lobed.
REMARKS	Bearing also fertile, closed, underground flowers.

BERBERIS VULGARIS. Barberry.

Family BERBERIDACEÆ.

A shrub, planted, or run wild in New England.
May, June. Native of Europe.

ROOT	Fibrous.
STEM	Branching, woody.
LEAVES	Alternate, simple, pinnate-veined, obovate, margin spiny, in clusters in the axils of branched spines, which are reduced leaves of the preceding season.
PETIOLE	Short, margined, jointed.
STIPULES	None.
INFLORESCENCE AND BRACTS.	Flowers in drooping, many-flowered racemes, from the centres of the clusters of leaves. Bractlets 2–6 surrounding each flower.
ÆSTIVATION.........	Calyx and corolla imbricated.
FLOWER	Regular, complete, symmetrical.
RECEPTACLE	Flat.

PERIANTH (leaves)...
CALYX (sepals)......Polysepalous, free, 6 sepals, the outer smaller, obovate, concave.
COROLLA (petals)....Polypetalous, hypogynous, 6 petals, obovate, concave, yellow, on short claws, with two little orange glands near the base.
STAMENS............6, distinct, hypogynous, opposite the petals.
FILAMENTS......Short and thick.
ANTHERS.......Innate, two-celled, opening by uplifted valves.
PISTIL............. Simple.
OVARY.........One-celled; ovules few, erect, anatropous.
STYLE..........None.
STIGMA.........Round, depressed in the centre.
FRUIT............ A berry, oblong, red and sour, with few seeds.
SEEDS..............Few, albuminous, dicotyledonous.
REMARKS...........The stamens are sensitive, and at a slight touch near the base fly up towards the pistil, discharging the pollen.

ARISÆMA TRIPHYLLUM. Jack-in-the-Pulpit. Indian Turnip.

Family ARACEÆ.

A perennial herb, with 1 or 2 compound leaves and a scape bearing numerous incomplete flowers on a spadix, sheathed by a large purple-veined bract; wet places.

Spring.

ROOT...............Fibrous, from a turnip-shaped, wrinkled corm, juice acrid.
STEM...............A scape, sheathed by the leaf petioles, bulbous.
LEAVES.............1 or 2, radical, palmately-compound, leaflets 3, elliptical-ovate, pointed, netted-veined, smooth, hollow.

Petiole ....Sheathing the flower-stalk for about half its length.

Stipules ....None.

Inflorescence and Bracts. ......Flowers monœcious or diœcious on a spadix, with a hooded spathe, green striped with purple; peduncle smooth, round, hollow. Leaves and flower-stalk enclosed in scaly bracts.

Æstivation ....Floral envelopes none, spathe convolute below, arching above.

Flower ....Incomplete.

Receptacle ....Prolonged into a fleshy spike, naked above, bearing the flowers below.

Perianth (leaves)...

Calyx (sepals)......None.

Corolla (petals)....None.

Stamens............Generally two.

Filaments......United.

Anthers ... ...Two or four-celled, opening by pores in the top.

Pistil..............Simple.

Ovary..........One-celled; ovules 5 or 6.

Style ....None.

Stigma ....Depressed.

Fruit ....A head of scarlet berries, smooth and shining.

Seeds ....1 or 2, round, with a large scar, monocotyledonous, albuminous.

CYPRIPEDIUM ACAULE. Lady's Slipper.

Family Orchidaceæ.

A monocotyledonous plant, with large, sheathing leaves, and a single showy, rose-purple flower; woods.

Height, 8 to 12 inches. May.

ROOT	Of tufted fibres.
STEM	Very short, underground.
LEAVES	2 alternate, large, sheathing, parallel-veined, entire, oval, downy.
PETIOLE	None.
STIPULES	None.
INFLORESCENCE AND BRACTS.	Flowers generally solitary on a downy scape, with a single bract.
ÆSTIVATION	(See diagrams, p. 172, Fig. 25.)
FLOWER	Complete, irregular, unsymmetrical.
RECEPTACLE	
PERIANTH (leaves)	
CALYX (sepals)	Polysepalous, free, 3 sepals, the two lower united, ovate-lanceolate, purplish, veined with darker parallel lines.
COROLLA (petals)	Polypetalous, epigynous, 3 petals, 2 lateral lanceolate, tapering to a sharp point, oblique, the other petal an inflated, drooping sac, with the edges turned inward, rose-colored, veiny.
STAMENS	3, one petal-like, sterile, covering the style.
FILAMENTS	Adnate to the style.
ANTHERS	2, two-celled, pollen loose and covered by a sort of sticky varnish.
PISTIL	3 carpels, syncarpous.
OVARY	Covered with glandular hairs, one-celled, 3 parietal placentæ; ovules many, small.
STYLE	Thick, making with the filaments a declined column.
STIGMA	Terminal, three-lobed, broad, moist, rough.
FRUIT	A pod.
SEEDS	Minute.
REMARKS	The bract is at the base of the flower, but

the flower is reflexed and twisted so that it appears to be at the top. (See diagram, p. 172.)

CAPSELLA BURSA-PASTORIS. Shepherd's Purse.

Family CRUCIFERÆ.

A very common annual weed, with radical leaves in a rosette, and inconspicuous flowers in a terminal raceme, which lengthens as the season advances.

Height, 6 to 18 inches. April to September.

ROOT	A strong and thick tap-root.
STEM	A short underground stem, throwing up erect, leafy scapes, hairy.
LEAVES	Radical and alternate on the flower-stems, variously incised, toothed, and pinnatifid, variable.
PETIOLE	Flat, margined, the cauline leaves sessile, clasping, and auricled.
STIPULES	None.
INFLORESCENCE AND BRACTS.	Flowers in terminal racemes, becoming much elongated. Bracts toothed.
ÆSTIVATION	Imbricated. (See diagrams, p. 186, Fig. 26.)
FLOWER	Complete, regular, small.
RECEPTACLE	Flat.
PERIANTH (leaves)	
CALYX (sepals)	Polysepalous, free, 5 sepals, ovate, hairy, deciduous.
COROLLA (petals)	Polypetalous, hypogynous, 4 petals, white, round, with short claws.
STAMENS	6, distinct, on receptacle.
FILAMENTS	4 long, 2 short (tetradynamous).

ANTHERS ....Two-celled, introrse, dehiscence longitudinal.[1]
PISTIL..............2 carpels, syncarpous.
OVARY..........Two-celled, by a thin, false partition which grows out from the two parietal placentæ, ovules many.
STYLE..........Very short.
STIGMA.........Capitate.
FRUIT..............A silicle, obcordate, the valves boat-shaped, falling away, leaving the seeds on the exposed placentæ.
SEEDS..............Many, cotyledons two, incumbent, exalbuminous.
REMARKS...........

STELLARIA MEDIA. Common Chickweed.

Family CARYOPHYLLACEÆ.

A common annual weed, prostrate and trailing, with opposite, entire leaves, and small white flowers in cymes; fields and cultivated grounds everywhere.

Flowers from February to December. Native of Europe.

ROOT...............Fibrous.
STEM...............Procumbent, diffuse, weak, hairy in a single line.
LEAVES............Opposite, simple, pinnately-veined, oval, apex acute, margin entire, thin, light green, lower leaves contracted at base.
PETIOLE........Lower leaves on hairy petiole, upper sessile.
STIPULES.......None.
INFLORESCENCE AND BRACTS......Flowers in terminal cymose clusters, or solitary.

[1] The flower is so small that the pupils cannot probably make out many of these points. They should never write in their descriptions what they cannot see for themselves.

FLOWER ....Complete, regular, symmetrical.
RECEPTACLE ....Flat.
ÆSTIVATION.........Imbricated.
PERIANTH (leaves)...
CALYX (sepals)......Polysepalous, free, 4 or 5 sepals, somewhat united at base, pedicels hairy, deflexed in fruit, lanceolate, persistent.
COROLLA (petals)....Polypetalous, more or less perigynous, 5 petals, two-parted, white, shorter than the calyx.
STAMENS............3 to 10, distinct, on receptacle.
FILAMENTS......Slender, round.
ANTHERS ....Two-celled, dorsifixed, introrse, dehiscence longitudinal.
PISTIL ....3 carpels, syncarpous.
OVARY ....One-celled, free central placenta; ovules many.
STYLES ....3.
STIGMAS ....On the inside of the divisions of the style.
FRUIT ....A pod, splitting into six valves.
SEEDS ....Campylotropous, covered with minute tubercles, albuminous.
REMARKS ....The plant often lives through the winter.

NEPETA GLECHOMA. Ground-Ivy.

Family LABIATÆ.

A trailing perennial weed, in waste grounds, with square stems, opposite, simple leaves, and small, blue, two-lipped flowers, clustered in the axils; roadsides, dooryards.

Height, 6 to 12 inches. May, June. Naturalized from Europe.

ROOT ....Fibrous, rooting at the base of stem.
STEM ....Procumbent, throwing up ascending branches, square, swollen at the joints, and very hairy.

LEAVES.............	Simple, opposite, palmately-veined, round, kidney-shaped, crenate, hairy.
PETIOLE........	Slightly channelled, long, hairy.
STIPULES.......	None.
INFLORESCENCE AND BRACTS......	Flowers in axillary, cymose clusters. peduncles very short.
ÆSTIVATION.........	Imbricated. (See diagrams, p. 192, Fig. 27.)
FLOWER............	Complete, irregular, unsymmetrical.
RECEPTACLE....	Flat.
PERIANTH (leaves)...	
CALYX (sepals)......	Gamosepalous, free, obliquely five-toothed, persistent.
COROLLA (petals)....	Gamopetalous, hypogynous, two-lipped, blue, spotted with purple, upper lip two-lobed, erect, lower lip three-lobed, declined, the middle lobe notched.
STAMENS............	4, distinct, ascending under the upper lip.
FILAMENTS......	Of two lengths (*didynamous*), the upper longer, on corolla.
ANTHERS.......	Two-celled, dehiscence longitudinal, the cells diverging after dehiscence, and each pair of anthers forming a cross.
PISTIL..............	4 carpels, syncarpous.
OVARY.........	Deeply four-lobed, with a gland at the base, 1 ovule in each cell.
STYLE..........	1, surrounded by the 4 lobes of the ovary.
STIGMAS........	2.
FRUIT..............	Splitting when ripe into 4 closed nutlets.
SEEDS..............	Erect, 1 in each nutlet, or some of the seeds aborted, with little or no albumen.
REMARKS...........	Plant aromatic. Some of the plants have smaller, female flowers, in which the anthers are club-shaped and sterile.

PEDICULARIS CANADENSIS. Wood-Betony.

Family SCROPHULARIACEÆ.

A perennial herb, with pinnately-parted leaves and large, thick spikes of sessile red and yellow two-lipped flowers, copses, common. Height, 5 to 12 inches. May, June.

ROOT	Clustered woody fibres.
STEM	Stout, hairy.
LEAVES	Alternate, lower leaves pinnately-compound, the upper lobed, the lobes crenate, hairy, revolute in the bud.
PETIOLE	Margined, hairy.
STIPULES	None.
INFLORESCENCE AND BRACTS.	Flowers at first in heads, elongating into spikes, densely-flowered; flowers sessile, each subtended by a crenate bract, the axis continued into a cluster of small leaves.
ÆSTIVATION	Lower lip of corolla covering the upper in the bud.
FLOWER	Complete, irregular, 1 inch long.
RECEPTACLE	Flat.
PERIANTH (leaves)	
CALYX (sepals)	Gamosepalous, free, oblique, entire, but split in front, hairy on the veins, persistent.
COROLLA (petals)	Polypetalous, flattened, on receptacle, two-lipped, upper lip recurved, hooded, two-toothed at the apex, enclosing the stamens and style, lower lip three-lobed, spreading, two-crested.
STAMENS	4, distinct, on receptacle.
FILAMENTS	Ascending under the upper lip, slender.
ANTHERS	Dorsifixed, flattened, two-celled, tailed at base, introrse, dehiscence longitudinal.

PISTIL ....2 carpels, syncarpous.
  OVARY ....Superior, two-celled, central placentation; ovules many.
  STYLE ....Long, slender, ascending under the upper lip.
  STIGMA ....Terminal, slightly two-lobed.
FRUIT ....A two-celled capsule, loculicidal, enclosed in the persistent calyx.
SEEDS ....Many, dicotyledonous, albuminous.
REMARKS ....

ZIZIA AUREA. Meadow-Parsnip.

Family UMBELLIFERÆ.

A perennial herb, growing in wet places and along streams, with large pinnately-compound leaves and small yellow flowers in compound umbels.

Height, 1 to 3 feet. May, June.

ROOT ....Fleshy and stringy, thick.
STEM ....Exogenous, underground a rootstock, above ground somewhat branched, erect, ribbed, hollow.
LEAVES.............Radical and cauline, alternate, 1 to 2 ternately-compound, leaflets 3, lance-ovate, oblique, serrate, often deeply lobed.
  PETIOLE ....Of radical leaves, channelled, triangular, dilated at the base; cauline leaves nearly sessile, dilated, and clasping.
  STIPULES ....None.
INFLORESCENCE AND BRACTS......Flowers in compound umbels, with a few awl-shaped bracts on the upper side of the umbellets, no involucre.
ÆSTIVATION.........Corolla valvate, with the point inflexed. (See diagrams, p. 198, Fig. 28.)

FLOWER ....Complete, regular, symmetrical.
RECEPTACLE ....Flat.
PERIANTH (leaves)...
CALYX (sepals)......Nearly obsolete, 5 very minute teeth, adnate to ovary.
COROLLA (petals)....Polypetalous, on an epigynous disk, 5 petals, yellow.
STAMENS............5, distinct, on an epigynous disk.
FILAMENTS......Round, smooth.
ANTHERS ....Capitate.
FRUIT ....Ten-ribbed, splitting into 2 oval, seed-like, dry carpels (*mericarps*).
SEEDS ....Suspended, dicotyledonous, albuminous.
REMARKS ....Between the ribs of the carpels are oil-tubes containing an aromatic oil. These are not very easily seen in this species.

RUMEX ACETOSELLA. Field-Sorrel.

Family POLYGONACEÆ.

A common perennial weed, making bright red patches in the meadows, with running stems, alternate, halberd-shaped leaves, and diœcious flowers in terminal panicles.

Height, 6 to 12 inches. Spring. Native of Europe.

ROOT...............Fibrous.
STEM ....Diffusely branched from the base, sending out runners, herbaceous.
LEAVES.............Alternate, simple, halberd-shaped, entire, auricled.
PETIOLE ....Margined.
STIPULES ....A scaly sheath.
INFLORESCENCE AND BRACTS......Flowers in terminal, naked panicles, diœcious. Bracts none.

ÆSTIVATION.........Valvate.
FLOWER........ ...Incomplete, diœcious, regular, greenish, becoming red.
RECEPTACLE ....Flat.
PERIANTH (leaves)...Six leaves, separate or somewhat united at base, very small, in the fertile flower the three inner divisions forming valves over the akene.
CALYX (sepals)......
COROLLA (petals)....
STAMENS............6, distinct, on receptacle.
FILAMENTS......Short.
ANTHERS ....Two-celled, basifixed, dehiscence longitudinal, the cells diverging after dehiscence.
PISTIL..............3 carpels, syncarpous.
OVARY .. ..Triangular, one-celled, one-ovuled; ovule orthotropous.
STYLE ....None.
STIGMAS ....3, hairy-tufted.
FRUIT ....An akene.
SEEDS ....Erect, dicotyledonous, albuminous.
REMARKS . ...The plant is agreeably acid to the taste.

PLANTAGO LANCEOLATA. English Plantain.

Family PLANTAGINACEÆ.

A common perennial weed, with dense spikes of small greenish flowers with fugacious stamens and filiform, persistent stigmas; fields and meadows, common.

Height, 9 inches to 2 feet. May, June. Introduced from Europe.

ROOT...............A strong tap-root.
STEM ....Very short.

LEAVES	Radical, simple, strongly parallel-ribbed, lanceolate, entire, hairy.
PETIOLE	Leaf tapering into a margined petiole.
STIPULES	None.
INFLORESCENCE AND BRACTS.	Flowers in a dense head, elongating into a spike, on naked, hairy scapes. Bracts scarious, one at the base of each flower.
ÆSTIVATION	Imbricated.
FLOWER	Complete, regular, symmetrical
RECEPTACLE	
PERIANTH (leaves)	
CALYX (sepals)	Polysepalous, free, sepals 4, the two lower combined into one, ovate, transparent with a green midrib ending in an acuminate tip.
COROLLA (petals)	Gamopetalous, hypogynous, salver-shaped, four-lobed, lobes lanceolate, thin, becoming scarious, persistent, enclosing the ovary in fruit.
STAMENS	4, distinct, on corolla.
FILAMENTS	Slender, exserted.
ANTHERS	Basifixed, innate, two-celled, ending in an awn-pointed tip, dehiscence longitudinal.
PISTIL	2 carpels, syncarpous.
OVARY	Superior, two-celled; ovules 1 in each cell.
STYLE	Slender, filiform, maturing before the stamens.
STIGMA	Long, exserted, hairy.
FRUIT	A capsule, with an opening across, making a lid.
SEEDS	2, hollowed on the inner face, shining, dicotyledonous, albuminous.
REMARKS	The flower is wind-fertilized.

TARAXACUM OFFICINALE. Dandelion.

Family COMPOSITÆ.

A perennial weed, common everywhere in open grounds, with radical, runcinate leaves in a rosette, and yellow heads of flowers on naked, hollow scapes.

April to November. Native of Europe.

ROOT	A thick, milky tap-root.
STEM	Very short.
LEAVES	Radical, lying on the ground in a rosette, runcinate, pinnate-veined.
PETIOLE	Margined.
STIPULES	None.
INFLORESCENCE AND BRACTS.	Flowers in large, solitary heads on hollow, milky scapes; involucre double, outer row of small scales, inner row single, narrow, erect in the bud, reflexed in the flower; flowers all ligulate.
ÆSTIVATION	Valvate.
FLOWER	Complete, regular.
RECEPTACLE	Flat, naked.
PERIANTH (leaves) ...	
CALYX (sepals)	Pappus of capillary bristles on the summit of the beak of the akene.
COROLLA (petals)	Gamopetalous, epigynous, strap-shaped, five-toothed, yellow.
STAMENS	5, united, on the corolla.
FILAMENTS	Short, distinct.
ANTHERS	Two-celled, syngenesious, dehiscence longitudinal.
PISTIL	Simple.
OVARY	Inferior, one-celled, one-ovuled; ovule erect.
STYLE	Two-cleft, developing after the stamens.

STIGMAS ....2, stigmatic on the inner surface of the divisions of the style.
FRUIT ....An akene, ribbed, the ribs roughened, the beak lengthened in fruit and bearing the pappus as a plume on top.
SEED ....1, dicotyledonous, exalbuminous.
REMARKS ....Used as a pot-herb in spring.

CHRYSANTHEMUM LEUCANTHEMUM. Ox-Eye Daisy.

Family COMPOSITÆ.

A common weed in eastern fields, with erect, simple stems, bearing large, terminal heads of flowers, disk yellow, rays white, leaves spatulate, clasping, the lower on margined petioles.

Height, 1 to 2 feet. June to July. Native of Europe.

ROOT ....Fibrous.
STEM ....Erect, hollow, strongly ribbed, simple, or branching from the base.
LEAVES.............Upper leaves sessile, spatulate or oblong, clasping, lower leaves tapering, cut-toothed, pinnate-veined.
PETIOLE ....Lower leaves with margined petiole, upper leaves sessile.
STIPULES ....None.
ÆSTIVATION.........Valvate.
INFLORESCENCE AND BRACTS......Flowers in large, solitary heads, $1\frac{1}{2}$ to 2 inches in diameter, of two kinds in each head; involucre closely imbricated, the scales lance-shaped, with rusty margins.
FLOWER ....Ray-flowers, 20 to 30 in a single row, pistillate, white, disk-flowers perfect, yellow.
RECEPTACLE ....Rather flat or convex, naked.
PERIANTH (leaves)...

Calyx (sepals)......Pappus none.
Corolla (petals)....Gamopetalous, epigynous, ray-flowers strap-shaped, five-toothed, white; disk-flowers tubular, five-toothed, yellow.
Stamens............5, united.
  Filaments......Distinct.
  Anthers.......Two-celled, syngenesious, dehiscence longitudinal.
Pistil............Simple.
  Ovary.........Inferior, one-celled, one-ovuled; ovule erect.
  Style..........1, two-lobed, branches flat, with a hairy apex.
  Stigmas........2, stigmatic on the inner surface of the style.
Fruit..............An akene, ribbed.
Seeds..............1, dicotyledonous, exalbuminous.
Remarks...........A pest to the farmers.

RUDBECKIA HIRTA. Black-Eyed Susan. Purple Cone-Flower.

Family Compositæ.

A biennial herb, with hairy stems and solitary, terminal heads with orange rays and a dark purple conical disk; fields. Height, 1 to 2 feet. June to August.

Root...............Fibrous.
Stem...............Simple, or branching near the base, erect, rough-hairy.
Leaves.............Alternate, radical and lower stem-leaves spatulate, three-nerved, tapering at base; upper stem-leaves oblong or lance-ovate, entire or slightly toothed, bristly-hairy.
  Petiole........Lower leaves narrowed into a margined petiole, upper leaves sessile.
  Stipules.......None.

INFLORESCENCE AND BRACTS.	Flowers in terminal heads, radiate; involucre leaf-like.
ÆSTIVATION	Valvate; involucre loosely imbricated, spreading.
FLOWER	Incomplete, ray-flowers neutral, disk-flowers perfect.
RECEPTACLE	Conical, chaff concave.
PERIANTH (leaves)	
CALYX (sepals)	Pappus none.
COROLLA (petals)	Rays few, orange, showy, neutral; disk-flowers purple, five-toothed, teeth spreading.
STAMENS	5, united, on corolla.
FILAMENTS	Short, distinct.
ANTHERS	Two-celled, introrse, syngenesious, dehiscence longitudinal.
PISTIL	Simple.
OVARY	Inferior, one-celled, one-ovuled; ovule erect.
STYLE	Two-cleft, with a short, triangular, tufted-hairy appendage at the tips.
STIGMA	Stigmatic on the inner surface of the divisions.
FRUIT	An akene, four-angled, flat at the top, smooth.
SEED	1, dicotyledonous, exalbuminous.
REMARKS	Introduced into Eastern fields with Western clover-seed.

ERIGERON BELLIDIFOLIUS. Robin's Plantain.

Family COMPOSITÆ.

A perennial herb, with spatulate, toothed, or entire leaves, and terminal heads on slender peduncles, with narrow violet rays and yellow disk; copses.

Height, 12 to 18 inches. Spring. North America.

Root	Clustered, fibrous.
Stem	Erect, sparingly branched, hairy, producing offshoots from the base.
Leaves	Radical and cauline, the former in a rosette, spatulate, toothed or entire, the latter distant, lance-oblong, clasping, entire.
Petiole	None on cauline leaves, radical leaves narrowed into a short petiole.
Stipules	None.
Inflorescence and Bracts.	Heads few, corymbose, many-flowered, of two kinds in the head; peduncle slender; scales of the involucre in a single row, hairy, narrow.
Æstivation	Valvate.
Flower	Rays numerous, pistillate, in one row, disk-flowers perfect.
Receptacle	Flat, naked.
Perianth (leaves)	
Calyx (sepals)	Pappus of soft hairs.
Corolla (petals)	Gamopetalous, epigynous, ray-flowers narrow, violet, disk-flowers tubular, yellow.
Stamens	5, united.
Filaments	Distinct.
Anthers	Two-celled, syngenesious, dehiscence longitudinal.
Pistil	Simple.
Ovary	Flattened; one-ovuled; ovule erect.
Style	Two-cleft, branches flat, triangular at apex.
Stigmas	Stigmatic on the inside of the divisions of the style.
Fruit	An akene, two-nerved.
Seeds	Dicotyledonous, exalbuminous.
Remarks	

ANTENNARIA PLANTAGINIFOLIA. *Plantain-leaved Everlasting.*

Family COMPOSITÆ.

A common weed, with crowded, spatulate, hoary leaves, and small, corymbed heads of white flowers, surrounded by papery involucres; woods and hillsides.

Height, 3 to 18 inches. March to May.

ROOT................	Fibrous, creeping.
STEM................	Spreading by offsets and runners, throwing up ascending flowering branches, woolly.
LEAVES..............	Alternate, crowded, spatulate, entire, woolly, on the flowering stems more distant, smaller, lanceolate, appressed.
PETIOLE........	Lower leaves with margined petiole, upper leaves sessile.
STIPULES.......	None.
INFLORESCENCE AND BRACTS......	Flowers in small heads, clustered in crowded corymbs; involucre of white, dry, transparent scales, broad and obtuse in the sterile, narrow and acute in the fertile flowers.
ÆSTIVATION.........	Valvate, involucre imbricated.
FLOWER............	Imperfect, diœcious, flowers all tubular (*discoid*).
RECEPTACLE....	Convex, naked.
PERIANTH (leaves)...	
CALYX (sepals)......	Pappus of a single row of bristles, thickened at the apex in the sterile flowers, capillary and united at the base in the fertile flowers.
COROLLA (petals)...	Gamopetalous, epigynous, white or yellowish, tubular, five-toothed, the tube filiform in the fertile flowers, broader in the sterile ones.

STAMENS ....5, united, on corolla.
FILAMENTS......Distinct.
ANTHERS ....Arrow-shaped, tailed, two-celled, syngenesious, dehiscence longitudinal.
PISTIL ....Simple.
OVARY......... Inferior, one-celled, one-ovuled; ovule erect.
STYLE ....Two-cleft in the fertile flowers, nearly simple in the sterile flowers.
STIGMA ....Stigmatic on the inner surfaces of the divisions of the style.
FRUIT ....An akene.
SEEDS ....1, dicotyledonous, albuminous.
REMARKS ....Named from the resemblance of the pappus of the sterile flowers to the antennæ of insects.

SENECIO AUREUS. Golden Ragwort.

Family COMPOSITÆ.

A common perennial, with simple, radical leaves, pinnatifid stem-leaves, and corymbs of yellow flowers. Species very variable. Height, 1 to 2 feet. May.

ROOT ....Fibrous.
STEM ....Simple, erect, smooth or woolly when young.
LEAVES ....Alternate, radical leaves simple, ovate, heart-shaped at base, toothed; lower stem-leaves lyrate, upper lanceolate, pinnatifid, thin, smooth.
PETIOLE ....Lower leaves on long petioles, upper leaves sessile, clasping.
STIPULES ....None.
INFLORESCENCE AND BRACTS......Heads, middle-sized, 1 inch broad, in corymbs. Bracts awl-shaped.

Æstivation....... .Corolla valvate, involucre scales in a single row, not imbricated, lanceolate, green.
Flower ....Rays 8 to 12, pistillate, disk-flowers tubular, perfect.
    Receptacle ....Naked, flat.
Perianth (leaves)...
Calyx (sepals)......Pappus of soft, white, capillary bristles.
Corolla (petals)....Rays yellow, five-toothed, disk-flowers five-lobed, with a long, slender tube, yellow, epigynous.
Stamens ....5, united, on corolla.
    Filaments......Short.
    Anthers ....Oblong, without tails, two-celled, united, introrse, dehiscence longitudinal.
Pistil ....Simple.
    Ovary ....Inferior, one-celled, one-ovuled; ovule erect.
    Style ....Two-cleft, branches capitate at the apex.
    Stigma ....Stigmatic on the inner surfaces of the style-branches.
Fruit ....An akene, ribbed.
Seeds ....1, dicotyledonous, exalbuminous.
Remarks ....This is the largest genus known.

ROBINIA PSEUDACACIA. Locust.

Family Leguminosæ.

A large tree, with odd-pinnate leaves, and white, fragrant flowers, in showy, hanging racemes.

Height, 40 to 50 feet. June. Cultivated and run wild in New England, native westward and southward.

Root ....Woody, with numerous fibres near the surface.
Stem ....Exogenous, bark furrowed, armed with stipular thorns when young.

LEAVES.............	Alternate, compound, odd-pinnate, leaflets many, oblong, mucronate, thin, smooth, pale green, vernation conduplicate.
PETIOLE	Swollen at base, covering the next season's buds.
STIPULES	None, or sharp thorns.
INFLORESCENCE AND BRACTS......	Flowers in long, drooping, axillary racemes.
ÆSTIVATION..	Imbricated, the upper petal covering the others in the bud.
FLOWER	Complete, irregular.
RECEPTACLE	
PERIANTH (leaves)...	
CALYX (sepals)	Gamosepalous, free, slightly five-toothed, oblique.
COROLLA (petals)....	Polypetalous, adnate to base of calyx, 5 petals, papilionaceous, standard large, notched, round, wings free, petals all with claws.
STAMENS............	10, united, on corolla.
FILAMENTS......	United, diadelphous, 9 and 1.
ANTHERS	Two-celled, dehiscence longitudinal.
PISTIL..............	Simple.
OVARY	Superior, one-celled, flat.
STYLE	Curved upward and enclosed with the stamens in the keel, bearded on the inner side.
STIGMA	Terminal capitate.
FRUIT	A pod, two-valved, flat, margined.
SEEDS	Few, dicotyledonous, exalbuminous.
REMARKS	

TRIFOLIUM PRATENSE. Red Clover.

Family LEGUMINOSÆ.

An herb, cultivated for fodder and run wild; fields.
1 to 2 feet high. Native of Europe.

ROOT	Fibrous.
STEM	Branching from the base, at first decumbent, then ascending.
LEAVES	Alternate, palmately-compound, leaflets 3, oval, marked with a triangular pale spot, apex rounded or retuse.
PETIOLE	Long, slender, hairy.
STIPULES	Large, veiny, bristle-pointed, hairy, adnate to petiole.
INFLORESCENCE AND BRACTS.	Flowers in dense heads, surrounded by leafy bracts.
ÆSTIVATION	Imbricated; upper petal, enclosing the others in the bud.
FLOWER	Complete, irregular.
RECEPTACLE	
PERIANTH (leaves)	
CALYX (sepals)	Gamosepalous, free, five-toothed, teeth bristle-form, long, and hairy.
COROLLA (petals)	Gamopetalous, perigynous, 5 petals, tube long, standard large, wings with a projecting appendage on the claw.
STAMENS	10, united, on corolla.
FILAMENTS	Diadelphous, 9 and 1.
ANTHERS	Two-celled, dehiscence longitudinal.
PISTIL	Simple.
OVARY	Superior, one-celled, several ovules.
STYLE	Sickle-shaped, curving upward.
STIGMA	Terminal, projecting above the stamens.

FRUIT	A legume, indehiscent.
SEEDS	1, kidney-shaped, dicotyledonous, albuminous.
REMARKS	Generally described as a perennial, but many writers assert positively that it is a biennial.

PISUM SATIVUM. Common Pea.

Family LEGUMINOSÆ.

A weak, climbing herb, cultivated. Flowering in early Summer.

ROOT	Fibrous.
STEM	Weak, climbing, smooth, angled, hollow.
LEAVES	Compound, 1 to 3 pairs, alternate, pinnate, ending in a tendril, leaflets ovate, retuse, pinnately veined, smooth, glaucous.
PETIOLE	None.
STIPULES	Large, leaf-like, ovate, oblique, crenate, base cordate.
INFLORESCENCE AND BRACTS.	Flowers axillary, 2 or 3 together.
ÆSTIVATION	Imbricated, upper petal covering the others in the bud. (See diagrams, p. 240.)
FLOWER	Complete, irregular.
RECEPTACLE	Flat.
PERIANTH (leaves)	
CALYX (sepals)	Gamosepalous, free, five-lobed, lobes lance-ovate, slightly two-lipped, persistent.
COROLLA (petals)	Polypetalous, perigynous, papilionaceous, white, standard large, erect, notched, wings roundish, longer than the curved keel.
STAMENS	10, diadelphous, perigynous.
FILAMENTS	United for about half their length.
ANTHERS	Dorsifixed, introrse, two-celled, dehiscence longitudinal.

PISTIL ....Simple.
  OVARY ....One-celled, with 1 parietal placenta, oblong, ovules few.
  STYLE ....Flattened, incurved, bearded, sickle-shaped.
  STIGMA ....Simple, terminal.
FRUIT ....A two-valved legume.
SEEDS ....Few, round, with two thick cotyledons, exalbuminous.
REMARKS ....Little visited by insects.

LUPINUS PERENNIS. Lupine.

Family LEGUMINOSÆ.

A perennial herb, with palmate leaves, and showy racemes of blue flowers; sandy soil.
Height, 1 to 2 feet. June.

ROOT ....A thick tap-root.
STEM ....Simple, erect, hairy.
LEAVES ....Alternate, palmately-compound, leaflets 7 to 15, oblanceolate, obtuse, silvery-haired beneath, vernation conduplicate.
  PETIOLE ....Long, hairy.
  STIPULES ....Adnate to stem.
INFLORESCENCE AND BRACTS. ......Flowers in long, loose racemes. Bracts caducous.
ÆSTIVATION ....Imbricated, upper petals covering the others in the bud.
FLOWER ....Complete, irregular, symmetrical.
  RECEPTACLE ....Flat.
PERIANTH (leaves)...
CALYX (sepals)......Gamosepalous, united to base of ovary, five-lobed, two-lipped.
COROLLA (petals)....Polypetalous, perigynous, 5 petals, papilionaceous, purple-blue.

STAMENS............10, monadelphous, perigynous.
  FILAMENTS......United.
  ANTHERS.......Of two forms, one form fertile, oblong, large, dehiscence longitudinal, the other sterile, club-shaped.
PISTIL..............Simple, joined to base of calyx.
  OVARY.........One-celled, sickle-shaped, ovules many.
  STYLE..........Curved, longer than stamens.
  STIGMA.........Terminal.
FRUIT..............A hairy, oblong legume, sometimes constricted between the joints, brown when ripe.
SEEDS..............Smooth, round, large, cotyledons fleshy, exalbuminous.
REMARKS...........

IRIS VERSICOLOR. Blue Flag.

Family IRIDACEÆ.

A perennial herb, with showy, blue, terminal flowers and equitant leaves, growing in marshy places.
Height, 1 to 3 feet. Flowering in early Summer.

ROOT...............Fibrous from an uneven, creeping rootstock.
STEM...............A rootstock, throwing up erect, stout, angled branches, fleshy.
LEAVES.............Alternate, parallel-veined, sword-shaped, 12 to 18 inches long, equitant.
  PETIOLE........None.
  STIPULES.......None.
INFLORESCENCE AND BRACTS......Flowers in terminal, few-flowered cymes, enclosed singly or in twos in a spathe of scaly bracts.
ÆSTIVATION.........Calyx convolute, corolla open.

FLOWER ....Complete, regular, symmetrical.

PERIANTH (leaves)...Six-parted, epigynous, the three outer divisions recurved, blue, variegated with green and yellow, and purple-veined, the three inner leaves smaller, erect, spatulate, blue.

CALYX (sepals)......

COROLLA (petals)....

STAMENS............3, distinct, on outer divisions of the perianth.

FILAMENTS......Flat and tapering, about the same length as the anther.

ANTHER........Linear, two-celled, basifixed, extrorse, dehiscence longitudinal.

PISTIL..............3 carpels, syncarpous.

OVARY.........Inferior, three-celled, central placentation; ovules many.

STYLE..........Three-parted, the divisions petal-like, two-lobed, opposite the stamens which they overarch.

STIGMA.........A lip near the apex of each division, stigmatic on the upper side.

FRUIT..............A capsule, triangular with rounded angles, loculicidal.

SEEDS..............Flattened, many, monocotyledonous, albuminous.

REMARKS...........

KALMIA LATIFOLIA. Mountain-Laurel.

Family ERICACEÆ.

A shrub, with ample corymbs of showy pink-and-white flowers and shining evergreen leaves; woods and rocky hillsides.
Height, 4 to 10 feet. June.

ROOT...............Woody, branching.

Stem	Exogenous, erect, branching, smooth.
Leaves	Alternate, clustered near the ends of the branches, simple, pinnate-veined, oval, acute, entire, evergreen, coriaceous, smooth, shining.
Petiole	Short, smooth.
Stipules	None.
Inflorescence and Bracts.	Flowers in terminal corymbs. Bracts awl-shaped; pedicels hairy and sticky.
Æstivation	Valvate.
Flower	Complete, regular, symmetrical, sticky.
Perianth (leaves)	
Calyx (sepals)	Gamosepalous, free, deeply five-cleft, divisions lance-linear.
Corolla (petals)	Gamopetalous, free, wheel-shaped at base, contracted into a short tube below, the wheel with ten spokes ending in pockets in the bell-shaped, plaited, five-lobed border, white or rose.
Stamens	10, distinct, free.
Filaments	Elastic, bent back, flying up when released.
Anthers	Dorsifixed, dehiscing by holes in the apex, erect in the bud, fitting into the pockets of the corolla in the flower.
Pistil	Compound, 5 carpels, syncarpous.
Ovary	Superior, hairy, five-celled, placentation central.
Style	1, recurved.
Stigma	Capitate.
Fruit	A capsule, globose, hairy.
Seeds	Many, dicotyledonous, albuminous.
Remarks	Not setting seed when unvisited by insects.

DIERVILLA TRIFIDA. Bush-Honeysuckle.

Family CAPRIFOLIACEÆ.

A shrub with erect stems, and small, yellow flowers in terminal and axillary cymes; rocks and hillsides.
Height, 1 to 4 feet. June.

ROOT	Fibrous.
STEM	Woody, exogenous, erect, spreading by suckers, which throw up simple, wand-like, leafy branches.
LEAVES	Opposite, pinnate-veined, ovate-lanceolate, acuminate, finely crenate, thin, smooth.
PETIOLE	Short, channelled.
STIPULES	None.
INFLORESCENCE AND BRACTS.	Flowers in three-flowered cymes, in the axils of the upper leaves, and terminal. Bracts minute.
ÆSTIVATION	Corolla imbricated.
FLOWER	Complete, slightly irregular.
PERIANTH (leaves)...	
CALYX (sepals)......	Epigynous, five-parted, divisions awl-shaped, persistent.
COROLLA (petals)....	Gamopetalous, epigynous, funnel-shaped, obliquely five-lobed, lobes oblong, reflexed, yellow, lower lobe large, slightly crested, golden, with a nectar-gland at its base.
STAMENS............	5, alternate, on corolla.
FILAMENTS......	United with corolla for about half their length, exserted.
ANTHERS	Dorsifixed, introrse, two-celled, dehiscence longitudinal.
PISTIL	2 carpels, syncarpous.
OVARY..........	Inferior, two-celled, placentation central; ovules many.

STYLE ....Slender, exserted.
STIGMA ....Capitate.
FRUIT ....A capsule, oblong, with a tapering beak, two-celled, septicidal.
SEEDS ....Many, dicotyledonous.
REMARKS ....

CONVOLVULUS SEPIUM.

Family CONVOLVULACEÆ.

A common, twining perennial, with sagittate leaves and rose-colored or white axillary flowers. Flowering in Summer.

ROOT ....Fibrous, from a filiform rootstock.
STEM ....Twining or trailing, slightly downy, marked with dark lines.
LEAVES.............Alternate, simple, sagittate, acute, hairy on the veins beneath.
PETIOLE ....Round, hairy above.
STIPULES ....None.
INFLORESCENCE AND BRACTS......Flowers solitary in the axils, enclosed in the bud in two acute, heart-shaped bracts; peduncle four-ribbed.
ÆSTIVATION.........Calyx imbricated, corolla convolute, plaited on the ribs.
FLOWER ....Regular, complete, symmetrical.
PERIANTH (leaves)..
CALYX (sepals)......Polysepalous, free, 5 sepals, lance-ovate.
COROLLA (petals)....Gamopetalous, free, trumpet-shaped, obscurely five-lobed, five-ribbed, rose-color, the ribs white.
STAMENS............5, distinct, on corolla.
FILAMENTS......Included, enlarged and hairy at base, and conniving around the style.

Anthers ....Basifixed, two-celled, dehiscence longitudinal, sagittate at base.
Pistil ....2 carpels, syncarpous.
Ovary..........Superior, one-celled or two-celled, placentation central.
Style ....Slender, included.
Stigma ....Two-lobed, lobes oblong.
Fruit ....A capsule, globose, opening by valves.
Seeds ....2, dicotyledonous, albuminous.
Remarks ....There are five openings to the nectar, between the bases of the filaments. The nectar is well protected from theft and rain by the connivent hairy filaments.

LYCOPERSICUM ESCULENTUM. Tomato.

Family Solanaceæ.

A common perennial garden-plant, cultivated for its fruit. June.

Root ....Fibrous.
Stem .. ..Herbaceous, erect, very bristly-hairy, fleshy.
Leaves.............Alternate, pinnately-compound, the divisions irregularly lobed and cut, with smaller leaflets intermixed.
Petiole ....Round, fleshy, hairy.
Stipules ....None.
Inflorescence and Bracts......Flowers in terminal, cymose clusters, becoming lateral and extra-axillary.
Æstivation.........Valvate, corolla induplicate.
Flower ....Complete, regular.
Receptacle ....
Perianth (leaves)...

CALYX (sepals)	Five-parted, free, divisions lance-linear, hairy.
COROLLA (petals)	Gamopetalous, free, rotate, five-lobed, lobes lance-ovate, somewhat reflexed, yellow.
STAMENS	5, distinct, joined to base of corolla.
FILAMENTS	Very short.
ANTHERS	Basifixed, two-celled, connivent, the tips extended, united, and somewhat recurved; pollen powdery.
PISTIL	Carpels 5 or more, syncarpous.
OVARY	Imperfectly celled, placentæ large; ovules many.
STYLE	Short and thick.
STIGMA	Terminal.
FRUIT	A berry, large, red, smooth, and shining; the placentæ form most of the eatable pulp.
SEEDS	Many, dicotyledonous, albuminous.
REMARKS	The number of parts is generally much increased in cultivation.

ASCLEPIAS TUBEROSA. Butterfly-Weed.

Family ASCLEPIADACEÆ.

A perennial, with erect, leafy stems, and terminal umbels of showy, orange-red flowers; dry hills and fields.

June.

ROOT	Thick and deep.
STEM	Erect, leafy to the top, branching, hairy.
LEAVES	Alternate and opposite, simple, lance-linear, veins much reticulated, hairy on the midrib beneath.
PETIOLE	Short or none.
STIPULES	None.

INFLORESCENCE AND BRACTS. ...... Flowers in terminal umbels, the umbels approaching each other and forming a corymb. Bracts small, lanceolate.

ÆSTIVATION .... Valvate. (See diagrams, p. 260.)

FLOWER .... Complete, regular, symmetrical.

RECEPTACLE ....

PERIANTH (leaves)...

CALYX (sepals)...... Deeply five-parted, free, divisions 5, lanceolate, reflexed, green.

COROLLA (petals).... Deeply five-parted, the oblong divisions reflexed, orange color.

STAMENS............ 5, united with each other and with the stigma.

FILAMENTS...... United in a column, bearing 5 hooded nectaries opposite the anthers, each containing a sharp, incurved horn.

ANTHERS ...... Two-celled, flat, introrse, each cell winged, leaving a slit between adjacent wings, at the top of which is a black gland, uniting adjacent pollen-masses.

PISTIL .... 2 carpels, united only by a disk above the true stigmas.

OVARIES .... 2, separate, one-celled, many ovuled.

STYLES .... Short, included in the staminal tube.

STIGMAS .... United by a fleshy, five-angled disk, above the stigmatic surface, which can be reached only through the slits between the anthers.

FRUIT .... A pair of follicles, often only one developing, pedicel deflexed in fruit.

SEEDS .... Many, dicotyledonous, albuminous, bearing a tuft of silky hairs.

REMARKS .... The visits of insects are necessary to fertilize this flower.

APOCYNUM ANDROSÆMIFOLIUM. Spreading Dogbane.

Family APOCYNACEÆ.

A smooth, branching perennial, with opposite, simple, entire leaves, and small rose-colored and white flowers in compound cymes. common ; roadsides and thickets.

Height, 2 feet. June, July.

ROOT .... Fibrous.

STEM .... Erect, branching, very smooth, bark tough.

LEAVES............. Opposite, simple, pinnate-veined, ovate, mucronate, entire, smooth above, downy beneath.

PETIOLE .... Very short.

STIPULES .... None.

INFLORESCENCE AND BRACTS...... Flowers in terminal, compound cymes. Bracts awl-shaped, minute.

ÆSTIVATION......... Calyx imbricated, corolla convolute. (See diagrams, p. 264.)

FLOWER .... Complete, regular, about 4 lines broad.

PERIANTH (leaves)...

CALYX (sepals)...... Gamosepalous, free, five-lobed, lobes acute.

COROLLA (petals).... Gamopetalous, free, bell-shaped, five-toothed, the teeth revolute, 5 triangular appendages near the base opposite the lobes.

STAMENS............ 5, distinct, on corolla; alternating with the stamens are 5 nectar-glands.

FILAMENTS...... Bent inwards, short and thick, hairy.

ANTHERS .... Sagittate, dorsifixed, extrorse, conniving over the pistil, connective prolonged into a membranaceous tip, base curving outward ; pollen granular.

PISTIL .... 2 carpels, united by the styles.

OVARIES .... 2, separate, one-celled, many ovuled.

STYLE ....Short, thick, divided across the centre, upper division two-lobed, glutinous, non-stigmatic.

STIGMA ....Stigmatic just below the division of the style.

FRUIT ....A pair of slender follicles.

SEEDS ....Many, dicotyledonous, albuminous, with a tuft of silky hairs at the apex.

REMARKS ....The fruit seldom forms.

NYMPHÆA ODORATA. Water-Lily.

Family NYMPHÆACEÆ.

An aquatic perennial, with large, floating, heart-shaped leaves, and pure-white flowers with golden stamens and pistil; ponds and still streams, common.

June to September.

ROOT ....From a thick rootstock.

STEM ....Rootstock, obscurely exogenous, submerged in soft mud.

LEAVES ....Radical, floating, simple, palmate-veined, heart-shaped, entire, thick, dark shining green above, often red beneath, involute in the bud.

PETIOLE ....Rising to the surface of the water.

STIPULES ....Close to the rootstock, triangular or kidney-shaped.

INFLORESCENCE AND BRACTS. ......Flowers solitary, axillary. Bracts none; peduncle pierced with tubes.

ÆSTIVATION ....Imbricated.

PERIANTH (leaves)...

CALYX (sepals)......Polysepalous and free, or nearly so, sepals 4, ovate, obtuse, green without, tinged with pink.

COROLLA (petals)....Polypetalous, perigynous, numerous, oval, obtuse, concave, pure white, gradually passing into the stamens.

STAMENS............Many, distinct, perigynous.

FILAMENTS......Outer broad, becoming slender towards the centre of the flower.

ANTHERS ....Adnate, introrse, two-celled, dehiscence longitudinal.

PISTIL..............Compound, carpels numerous, syncarpous.

OVARY..........Many-celled; ovules on the walls, except at the ventral suture.

STYLE ....None.

STIGMAS ....Radiate from a globular head at the top of the axis; ending in sterile, incurved tips, golden yellow.

FRUIT ... .A capsule, maturing under water, covered by the withered petals.

SEEDS ....Many, dicotyledonous, albuminous, with an aril.

REMARKS ....The flowers open in the morning and close at nightfall, lasting several days; they are very fragrant.

We need a special form of description for grasses. The homology of the parts is so much disputed that it is not wise for us to attempt to classify them under the heads of bracts and perianth. It is better to use special names, as glumes, palet, and lodicules.

ANTHOXANTHUM ODORATUM. Sweet-Vernal Grass.

Family GRAMINEÆ.

A low, perennial grass, fragrant in drying, but not much liked by cattle, common in pastures and meadows.
Height, 1 to 2 feet. May to July.

ROOTS.............Fibrous.

STEM ....Erect, hollow, smooth, slender.

LEAVES	Simple, alternate, parallel-veined, slightly hairy, ligule oblong, obtuse, sheath slightly inflated.
PETIOLE	None.
STIPULES	None.
INFLORESCENCE OF CLUSTER	A terminal contracted panicle.
SPIKELETS	One-flowered, flower apparently terminal.
GLUMES	Empty glumes 4, first glume thin, ovate, one-nerved, half as long as the second, which is thin and three-nerved; third glume notched at the apex, and long-awned on the back, from below the middle, hairy; fourth glume similar, short-awned from below the tip.
FLOWERING GLUME	Round, obtuse, transparent.
PALET	Like the flowering glume.
LODICULES	None.
STAMENS	2, distinct.
FILAMENTS	Exserted, slender.
ANTHERS	Two-celled, versatile; pollen powdery.
PISTIL	Simple.
OVARY	One-celled, one-ovuled.
STYLE	None.
STIGMAS	2, long and feathery (*plumose*).
FRUIT	A caryopsis.
SEED	1, monocotyledonous, with floury albumen, grain adherent to the palet.

The schedule on the following page does not pretend to be complete. It is the work of a pupil of sixteen who had taken six lessons on flowers. Only the characters differing from those of the Cherry are given in the second and third columns.

	Cherry.	Apple.	Strawberry.
Plant	Tree, dicotyledonous.		Herb.
Root	Fibrous.		
Stem	Woody, branching.		Underground rootstock, sending out runners.
Leaves	Clustered, simple, oval, apex acute, serrate; petiole channelled; stipules lance-shaped.	Petiole thick, downy beneath.	Radical, compound, 3 leaflets, palmate, obovate, apex obtuse, dentate; petiole long, channelled; stipules ovate, joined to stalk.
Inflorescence	In axillary, cymose clusters.		A cyme.
Flower	Complete, regular.		
Calyx	Gamosepalous, 5 lobes, ovate, reflexed, free from ovary.	Lanceolate, joined to ovary.	5 bractlets between lobes, ovate, free.
Corolla	Polypetalous, 5 petals, white, joined to calyx.		
Stamens	Many, distinct, joined to calyx.		
Pistil	Simple.	Compound, 5 carpels, united.	Compound, carpels separate.

INDEX AND GLOSSARY.

Abortive, imperfect, rudimentary.

Acaulescent, apparently stemless, the stem subterranean.

Accessory, something additional; *accessory* buds, I. 90; *accessory* fruits, II. 148.

Accumbent cotyledons, II. 231.

Achlamydeous, without floral envelopes.

Acorn, the fruit of the Oak, II. 113.

Acuminate, tapering to a point.

Acute, ending in a point less than a right angle, I. 125.

Adnate, growing to, adherent; *adnate* anther, II. 59.

Adnation, II. 6.

Adventitious, out of its normal place; *adventitious* buds, I. 46, 82.

Aërial roots, I. 40.

Æstivation, the arrangement of the parts in a flower-bud, II. 46, 182.

Aggregate fruits, II. 148.

Air, purification of the, I. 5.

Air-plants, II. 173.

Akene, or *achenium*, II. 73, 135.

Alæ, wings, II. 234.

Albumen of the seed, food stored outside of the embryo, I. 25.

Albuminous, possessing albumen, I. 26, II. 231.

Alternate (leaves), one at each joint of stem, I. 94; parts in a flower-bud, II. 184.

Ament, II. 106–208.

Amphitropous, ovules or seeds, II. 229.

Anatropous, ovules or seeds, II. 229.

Andrœcium, the whole male portion of the flower, II. 82, note.

Androgynous, having male and female flowers in the same cluster, II. 169.

Androus, used in compounds, meaning of the stamens.

Anemophilous, flowers fertilized by the wind, II. 103.

Angiospermous, with seeds in a closed ovary, II. 86.

Angular, divergence of leaves, I. 95.

Annual, a plant which flowers, fruits, and dies in a single year. I. 42.

INDEX OF PLANTS.

SIXTY FAMILIES OF FLOWERING PLANTS.

This chart is intended as an aid for beginners in classifying plants. These sixty families contain 2475 species belonging to 684 genera, or about four-fifths of all the species and three-fourths of all the genera, to be found in the sixth edition of the Manual of the Flora of the Northern United States. The families unrepresented in this chart can be traced to their proper group, and will be found in this group, without much difficulty, by the aid of the synopsis in the Manual.

Of course, in a plan so very general, numerous exceptions must be expected. The families cannot be arranged in a single series in such a manner as to show many relationships; for their connections ramify in all directions, and can only be represented by a tree. The chart must be regarded as an aid in arranging plants into groups of families, which are natural in so far as they represent a real attempt at classification which shall have some relation to descent.

The chart follows the arrangement of Gray's Manual, with few exceptions. The Gymnosperms are no longer a subclass of the Dicotyledons, but are placed in a separate class at the end. This is on account of their close relationship with the higher orders of Cryptogams, which would follow, were we to pursue the classification further. German authors group the apetalous plants with the polypetalous families. Teachers who care to use this system of classification will find it in Goebel's Outlines, and a study of the orders, following Goebel with some changes, in Douglas Campbell's Structural Botany.[1]

Two families have their places altered, merely for convenience in grouping,—*Polygalaceæ* and *Plantaginaceæ*. The rest of the arrangement follows the Manual.

[1] Structural Botany. By Douglas Campbell. Ginn & Co., Boston, 1891.

SIXTY FAMILIES OF

l. = leaves; fl. = flowers; s. = sepals; p. = petals; st. = stamens; ov. = ovary;

					Latin Name.	Common Name.
ANGIOSPERMS.	DICOTYLEDONS.	POLYPETALOUS.	COROLLA AND STAMENS UNDER THE OVARY (HYPOGYNOUS).		Ranunculaceæ.	Crowfoot.
					Berberidaceæ.	Barberry.
					Nymphæaceæ.	Water-Lily.
					Papaveraceæ.	Poppy.
					Fumariaceæ.	Fumitory.
					Cruciferæ.	Cress.
					Violaceæ.	Violet.
					Caryophyllaceæ.	Pink.
					Portulacaceæ.	Portulaca.
					Hypericaceæ.	St. John's-wort.
					Malvaceæ.	Mallow.
					Geraniaceæ.	Geranium.
					Polygalaceæ.	Polygala.
			COROLLA AND STAMENS AROUND THE OVARY (PERIGYNOUS).		[1] Sapindaceæ.	Soapberry.
					Leguminosæ.	Pulse.
					Rosaceæ.	Rose.
					Saxifragaceæ.	Saxifrage.
					Crassulaceæ.	Orpine.
			COROLLA AND STAMENS ON TOP OF THE OVARY (EPIGYNOUS).		Onagraceæ.	Evening Primrose.
					Umbelliferæ.	Parsley.
					Araliaceæ.	Aralia.
					Cornaceæ.	Cornel.
		GAMOPETALOUS.	OVARY INFERIOR.		Caprifoliaceæ.	Honeysuckle.
					Rubiaceæ.	Madder.
					Compositæ.	Composite.
					Lobeliaceæ.	Lobelia.
					Campanulaceæ.	Campanula.
			OVARY SUPERIOR.	COROLLA REGULAR.	[1] Ericaceæ.	Heath.
					Primulaceæ.	Primrose.
					Apocynaceæ.	Dogbane.
					Asclepiadaceæ.	Milkweed.
					Gentianaceæ.	Gentian.
					Polemoniaceæ.	Polemonium.
					Borraginaceæ.	Borage.
					Convolvulaceæ.	Convolvulus.
					Solanaceæ.	Nightshade.
					Plantaginaceæ.	Plantain.
				COROLLA IRREGULAR.	Scrophulariaceæ.	Figwort.
					Verbenaceæ.	Verbena.
					Labiatæ.	Mint.
		APETALOUS.	FLOWERS NOT IN CATKINS.		Amarantaceæ.	Amaranth.
					Chenopodiaceæ.	Pigweed.
					Polygonaceæ.	Buckwheat.
					Euphorbiaceæ.	Spurge.
					Urticaceæ.	Nettle.
			FLOWERS IN CATKINS.		Juglandaceæ.	Walnut.
					Cupuliferæ.	Oak.
					Salicaceæ.	Willow.
	MONO-COTYLEDONS.	PETALOIDEOUS.	OVARY INFERIOR.		Orchidaceæ.	Orchis.
					Iridaceæ.	Iris.
					Amaryllidaceæ.	Amaryllis.
			OVARY SUPERIOR.		Liliaceæ.	Lily.
					Commelinaceæ.	Spiderwort.
					Juncaceæ.	Rush.
		SPADICEOUS			Typhaceæ.	Cat-tail.
					Araceæ.	Arum.
					Naiadaceæ.	Pondweed.
		GLUMACEOUS			Cyperaceæ.	Sedge.
					Gramineæ.	Grass.
GYMNOSPERMS					Coniferæ.	Pine.

[1] Members of this family belong also in the preceding group.

FLOWERING PLANTS.

fr. = fruit; reg. = regular; irreg. = irregular; alt. = alternate; opp. = opposite.

Herbs; fl. usually reg.; parts all distinct; st. many.
Shrubs and herbs; fl. reg.; parts distinct; st. opp., few.
Aquatic herbs; l. peltate; ovules not on the margins of the carpels.
Herbs; fl. reg.; s. fugacious; ov. 1-celled, with parietal placentæ.
Herbs; fl. irreg.; 4 p.; 6 diadelphous st.; ov. 1-celled.
Herbs; fl. reg.; 4 p.; 6 tetradynamous st.; ov. usually 2-celled.
Herbs; fl. irreg., 1-spurred; ov. 1-celled, with 3 parietal placentæ.
Herbs; fl. reg; parts in fives; free central placenta.
Herbs; fl. reg.; 2 s., 5 p.; ov. 1-celled, with ovules from the base.
Shrubs and herbs; st. in 3 bundles; ov. 1-celled or several-celled.
Shrubs and herbs; fl. reg.; st. many, monadelphous; carpels in a ring.
Chiefly herbs; parts in fives; carpels sometimes 3.
Herbs; fl. irreg.; st. 6, monadelphous or diadelphous; ov. 2-celled, 2-seeded.

Trees and shrubs; st. on a fleshy disk; ov. 2 to 3-celled; seeds exalbuminous.
Plants with papilionaceous, rarely reg., corolla; fr. a legume.
Plants with reg. fl.; l. alt., with stipules; st. many.
Shrubs or herbs; like Rosaceæ, but with opp. as well as alt. leaves, and no stipules.
Succulent herbs; fl. symmetrical; carpels generally distinct.

Herbs; fl. reg.; parts in fours; calyx valvate; corolla convolute.
Plants; fl. reg., in umbels; parts in fives, except 2 carpels; fr. dry, seed-like.
Herbs; fl. reg., in umbels; fr. a drupe.
Trees and shrubs (rarely herbs); fl. reg., not in umbels; fr. a drupe.

Shrubs (rarely herbs); l. opp., without stipules; corolla tubular or rotate.
Shrubs and herbs; l. opp., with stipules; corolla reg.
Herbs; fl. in heads, with involucre; anthers united; fr. an akene.
Herbs, with milky juice; fl. irreg., scattered; anthers united; seeds many.
Herbs, with milky juice; corolla bell-shaped; st. distinct; seeds many.

Shrubs and herbs; fl. reg. or irreg.; anthers usually opening by pores.
Herbs; l. simple; st. opp.; free central placenta.
Herbs, with milky juice; l. entire; carpels 2, becoming follicles.
Like Apocynaceæ, but with anthers connected with the stigma and pollen in masses.
Herbs; l. entire, sessile; ov. 1-celled, with 2 parietal placentæ.
Herbs; l. alt. or opp.; style 3-cleft; ov. 3-celled.
Herbs; rough-hairy; l. alt.; ov. 4-lobed, separating into nutlets.
Twining herbs; l. alt; p. convolute; parts in fives, except 2 carpels.
Herbs (rarely shrubs); l. alt.; corolla imbricated or valvate; ovules many.
Herbs; l. radical; fl. in spikes; parts in fours; corolla papery, dry.

Herbs; corolla 2-lipped; st. of 2 lengths or 2; ov. 2-celled, many-ovuled.
Shrubs and herbs; l. opp.; ov. not lobed, but splitting into 4 nutlets.
Herbs; stems square; l. opp.; corolla 2-lipped; ov. deeply 4-lobed.

Weeds; fl. imbricated, with usually 3 dry bracts; st. hypogynous; ov. 1-celled.
Ugly greenish weeds; succulent; st. opp. the calyx lobes; ov. 1-celled.
Herbs; l. alt., with sheathing, scaly stipules; stem-joints swollen; ov. 1-celled.
Plants, with milky juice; ov. superior, 3-celled; ovules pendulous.
Plants, with reg. calyx and st. opp. its lobes; seeds exalbuminous.

Trees; l. alt., pinnate; monœcious; fertile fl. solitary; ov. inferior.
Trees or shrubs; l. alt., simple; monœcious; fertile fl. solitary or clustered.
Trees or shrubs; diœcious; both kinds of fl. in catkins, 1 under each bract.

Herbs; l. alt.; fl. irreg.; st. 1 or 2, united to stigma; pollen in masses.
Herbs; l. equitant; fl. reg.; st. 3, anthers extrorse; ov. 3-celled.
Herbs; l. linear, flat; st. 6, anthers introrse; ov. 3-celled.

Mostly herbs; divisions of the perianth colored alike; st. 6; ov. 3-celled.
Herbs; perianth with distinct calyx and corolla; anthers with separated cells.
Herbs; fl. reg.; sepals 6, glumaceous; st. 6, rarely 3; ov. 3-celled or 1-celled.

Marsh or aquatic herbs; monœcious; l. linear, sessile; no floral envelopes.
Plants, with acrid juice; spadix generally with a spathe; fr. a berry.
Marsh or aquatic herbs; l. sheathing; perianth herbaceous, valvate or none.

Herbs; stem solid; l. 3-ranked, with closed sheaths; ov. 1-celled.
Herbs; stem hollow; l. 2-ranked, with split sheaths; ov. 1-celled.

Trees or shrubs; juice resinous; l. needle-shaped, evergreen; no floral envelopes.

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